Second Edition

Crime Scene Processing and Investigation

WORKBOOK

Christine R. Ramirez | Casie L. Parish-Fisher

Practical Aspects of Criminal and Forensic Investigations Series

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Crime Scene Processing and Investigation Workbook

Second Edition

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Christine R. Ramirez and Casie L. Parish-Fisher

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Chapter 1

Introduction

Key Terms

Crime prevention
Crime repression
CSI effect
Evidence
Testimonial evidence
Physical evidence
Predictable effects
Unpredictable effects
Transitory effects
Relational details
Functional details

Learning Outcomes

1. Discuss what is meant by the "interpretive value of evidence."
2. Understand the CSI effect and its effects on society.
3. Describe physical and testimonial evidence.
4. Explain methodology as it relates to crime scene examination, and describe the five components of a good processing methodology.
5. List and describe the three crime scene integrity issues.

1.1 Evaluating the Interpretive Value of Evidence

Objective

- Review crime scene material and identify key evidence. Once identified, evaluate the evidence and surrounding clues by using the five contexts of evidence described in the Concept Overview.

Concept Overview

The value of evidence is more than its presence at a crime scene. The context in which an item is found is sometimes more valuable than the item itself. The responsibility falls on the first responding officers and crime scene personnel to be studious of the crime scene and observe conditions that may be invaluable to solving a case.

When considering the context of evidence, Rynearson and Chisum offered that such context might manifest itself in a number of ways. They classified these manifestations as:

- Predictable effects—Regular changes one would expect to see at the scene or in evidence.
  Example: Insect activity at a homicide scene.
- Unpredictable effects—Unexpected changes one would not expect to see at a crime scene. This is especially disastrous to an investigation, as it could lead to a misinterpretation of the scene.
  Example: The altering of the crime scene by crime scene personnel.
- Transitory effects—Fleeting changes within a crime scene.
  Example: The smoke from a burning cigarette.
- Relational details—Details that help to establish a relationship among items at the scene and rely on the ability of personnel to properly place items within a crime scene.
  Example: Recognition of a void pattern on a wall with blood spatter.
- Functional details—The operating condition of items found at the scene.
  Example: A nonfunctional wristwatch found on a victim.

Materials

- Writing utensil

Procedure

1. Evaluate scene photographs.
2. Complete the Evaluation Worksheet.
3. Complete the Post Lab Questions.

Evaluation Worksheet

Photograph: _____

Item	Context	Justification

Photograph: _____

Item	Context	Justification

Photograph: _____

Item	Context	Justification

Photograph: _____

Item	Context	Justification

Post Lab Questions

1. Why is it important to observe the context of evidence at a scene?
2. Give two examples of transitory effects.
3. Is testimonial evidence more valuable than physical evidence? Explain.
4. In evaluating the photographs, what was the most difficult part?
5. Review the following list of items and notate the context of evidence. Be sure to justify your answer. (Make no assumptions as to the time or type of crime.)

   (More than one context could apply; if so, explain your answer.)

   a. Livor mortis in a body
   b. A home security alarm that is not activated, but the door is open
   c. A handgun under the victim's body
   d. The smell of perfume in a male victim's bathroom
   e. Police clearing a home with no regard to evidence
   f. A dirty mattress impression on the floor of a basement
   g. A jammed gun

1.2 CSI Effect

Objective

- Describe the CSI effect.
- Identify several of the basic objectives used to meet the goals of law enforcement.
- Identify and describe examples of physical evidence and testimonial evidence.
- Identify and describe several scene context classifications.
- Explain how the CSI effect could affect trial jury members.

Concept Overview

Law enforcement has two basic goals: first, the prevention of crime and disorder, and the preservation of peace, and second, the protection of life, property, and personal liberty. These are accomplished through five basic objectives:

1. *Crime prevention*: This includes the actions and efforts designed to keep crime from occurring. Community programs, youth programs, and proactive directed patrol are all good examples of crime prevention.
2. *Crime repression*: When crime prevention fails, law enforcement must then seek to repress the crime that is occurring. Actively pursuing the assailants leads to more apprehensions and enhanced community security.
3. *Regulating noncriminal conduct/patrolling*: Law enforcement must also work to control the general area and its occupants. Obeying city ordinances and traffic regulations helps to prevent chaos.
4. *Provision of services*: A police officer's main priority is the safety and well-being of the citizens. This is the largest category of service an officer may provide that includes everything from changing a motorist's tire to looking for a lost child.
5. *Protection of personal liberty*: Police must exercise a directive to protect citizens from unwarranted police interference regarding their personal liberties. In so doing, officers must also control their own actions in abiding by the Constitution and the laws of their governing state. This is an act of obeying the law without obstructing the law.

Evidence is used to prove an alleged matter of fact. Testimonial evidence is collected through an interview or interrogation of a witness, suspect, or other various subjects involved with the scene. Physical evidence takes the form of specific items found within the scene. They are often collected and submitted to a laboratory for further analysis and possibly presented in court. Whether submitted to a laboratory or not, all physical evidence should be documented through photography and sketching at the scene. Both types of evidence are crucial to an investigation, allowing investigators to fully reconstruct what may have occurred.

The CSI effect is the false or exaggerated perception of forensic science techniques by the general public, which influences their opinions. The term is most commonly used in reference to jurors who expect flashy scientific techniques in trials. The trend started with early criminal investigation shows, such as *Quincy, M.E.*, and began to explode in the late 1990s and early 2000s with the increasing popularity of crime dramas, such as *CSI*. Noticeable effects of the television shows include increased casework in criminal laboratories and the dramatic increase in the number of forensic science programs at colleges and universities. While the shows are entertaining, they have been criticized for failing to portray forensic techniques accurately and for misleading students concerning the actual work conducted. Another possibility is that the shows aid criminals by depicting methods of evidence disposal and destruction, thus making it more difficult for law enforcement to solve crimes.

Materials

- Paper (for note taking)
- Writing utensil

Procedure

1. Read literature concerning the CSI effect.
2. View the instructor-provided presentation.
3. During viewing, take notes concerning the context of the following within the presentation:
   - One or more of the basic objectives used to meet the goals of law enforcement:
     - Crime prevention
     - Crime repression

  - Regulation of noncriminal conduct
  - Provision of services
  - Protection of personal liberty
- Examples of physical evidence and testimonial evidence, if any.
- Examples of scene context classifications:
  - Predictable effects
  - Unpredictable effects
  - Transitory effects
  - Relational details
  - Functional details

4. Complete the Evaluation Worksheets.
5. Complete the Post Lab Questions.

Evaluation Worksheet

Law Enforcement Objective	Plot Depiction
Crime prevention	
Crime repression	
Noncriminal conduct	
Provision of services	
Protection of personal liberty	

Evaluation Worksheet

Physical Evidence	Testimonial Evidence
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

Evaluation Worksheet

Scene Context Classifications	Plot Depiction
Predictable: Regular changes one would expect to see at a crime scene	
Unpredictable: Unexpected changes one would not expect to see at a crime scene	
Transitory: Fleeting changes	
Relational: Establishment of relationship between items at a crime scene	
Functional: Whether items within the scene are working properly or not	

Post Lab Questions

1. What is the CSI effect?
2. How could the CSI effect affect trial jury members?
3. Why is it important to understand the shortfalls of television shows?
4. How could the shows aid criminal activity?
5. Give an example of how a police officer can violate the law while on duty.
6. What are the two types of evidence? Why is it helpful to have both types?

1.3 Crime Scene Examination: Methodology and Integrity Issues

Objective

- Review the crime scene synopsis and identify the components of the methodology employed. Subsequently, describe the integrity issues encountered in the scene and offer strategies for prevention.

Concept Overview

Crime scene investigation is not a task to be conducted haphazardly. The gravity of outcomes and consequences begs for a systematic undertaking and utilization of methodology. Simply put, methodology is a set of rules or procedures by which one carries out a task. There is nothing magical about methodologies. They are not an abstract concept only understandable by erudite academicians. They are used commonly, daily in fact, by people from all walks of life without being labeled or articulated as such. In short, it is the manner and order of how we do particular things. Rather than shy away from or have disdain for methodology, those who are charged with investigative tasks and duties should embrace this concept and consider it an anchor and guidepost.

As there are many pathways to a journey's end, there are various ways to process a crime scene. The fact that there is no book or periodical that can relay or outline the one proper way to process a crime scene is unsettling to some and irritating to many. This reaction is mostly from those who have yet to work in this profession or have limited experience in it. Those who are seasoned realize that there is no one right way to process a scene, because no two crime scenes are alike. Scenes may have some similarities, but each has its own variables and unique context. Regardless of the circumstances, characteristics, and contexts, there is an overall goal of scene processing: minimize scene alteration as much as possible, recover as much evidence as possible, and memorialize the scene as thoroughly as possible via various forms of documentation to capture the essence of the scene. While there is no sequentially enumerated doctrine or ordinance proffering a singular procedure for crime scene processing, a successful methodology or process will include the following components: knowledge, skills and tools, methodical approach, flexibility, and coordinated effort.

A crime scene investigator must be knowledgeable on several fronts. First, there should be an understanding of the importance of physical evidence to a criminal investigation. Verbal statements may change for various reasons, and eyewitness accounts and testimony may be malleable as memories fade, but physical evidence is what it is and does not lie. It is what CSIs seek. When found, there must be an understanding of its value within the context of the scene, and that understanding comes with information. Scene search and processing cannot occur successfully in a vacuum. Investigators must know for what they are searching and have as much information as possible in order to recognize items as evidence as well as their value and meaning as related to the scene event. Further, once identified as evidence, investigators must be knowledgeable in collection, packaging, and preservation. A deficit in any one of these areas could compromise evidence.

Successful scene processing requires tools. These range from documentation equipment such as survey equipment to digital cameras. Latent print processing equipment ranges from fingerprint brushes and powder to dye stains. Aside from forensics-minded items, tools found at hardware stores should be a part of every investigator's "tool kit." These include a hammer, multiple types of screwdrivers, saws, bolt cutters, standard wrench, pipe wrench, and utility knife. It is beneficial to have an array of tools and equipment for scene processing; it is imperative CSIs have the training and skill to utilize what they have, and competency with this equipment must be maintained.

Scene investigations must be carried out with a methodical approach. Post scene assessment and information briefing, the investigator begins scene processing in a manner that is meaningful for the contextual information received, and the process of documentation and evidence identification as well as all tasks related to the scene's evidence is carried out in a purposeful and deliberate manner. Scene investigation and processing, regardless of the scene, encompasses, the vast majority of the time, the same tasks: documentation, evidence identification, evidence collection, evidence packaging, evidence transport, and evidence preservation. Typically, the order of tasks is as it was just listed. However, there are occasions when circumstances require a reordering of tasks. Scenes can be very dynamic and compel the CSI to engage in critical thinking and display flexibility in order to problem-solve. Examples of such occasions are those that occur prior to documentation when fragile evidence is on the cusp of being lost, and the loss/destruction of evidence located outdoors as climactic events affect the scene. While it is important to have and employ scene processing methodology, it is equally important to have the awareness and capacity to diverge from a process when necessary and beneficial for the scene investigation rather than continue with process for the sake of process.

Not all investigators have the luxury of working with others on scenes. Many times, the mantra is "one scene, one CSI." This typically is not out of desire or hubris but from lack of personnel and resources. When there is a team effort, it is imperative that there is a coordinated effort. This results when all parties have sufficient information to participate in the investigation, and they are aware of each other's tasks and responsibilities. Through information sharing and communication, all tasks are assigned and carried out, and redundancy does not occur.

The goal of capturing and documenting a scene in pristine condition is threatened and may be compromised by scene integrity issues: adding material to the scene, destroying material in the scene, and moving material in the scene. The addition of material to a scene creates postincident artifacts, and these are typically created by first responders such as police officers, EMS, and fire personnel. Examples of such artifacts are footwear impressions and outdoor debris. If not observed during creation or explained after occurrence, postincident artifacts can affect what a CSI identifies as scene evidence and how the scene will be processed. An object's evidentiary value is lost when destruction of material occurs. Examples of such destruction are inadvertently stepping on evidence in a scene, and examining a bloody knife over a water-filled sink and dropping the knife in the sink. While such destructive acts are not intentional, they have a negative impact on the investigation. Because reaction to destruction is too little too late, one method of combating this issue is being proactive. One approach is employing the concept of "authorized versus essential" personnel. Those who are authorized have the authority to enter the scene; those who are essential have the authority and are assigned a specific investigative task within the scene. Allowing only essential personnel in the scene will reduce the probability and occurrence of destruction. Another strategy is anticipating the actions of others entering the scene by calling to their attention specific areas of evidence and suggesting caution. Movement of material is an integrity issue that can affect an investigator's assessment and conclusion concerning interrelationships of evidence. Examples of moving material in a scene are the movement of furniture or household items by EMS upon their arrival to render aid, removing a firearm from the hand of a decedent, and unloading the weapon prior to an investigator's arrival, without documenting the condition of the weapon. Simple actions such as turning lights on or off and closing doors and windows can impact assessment and affect the investigation. It is important for investigators to speak with those who arrived prior to them and determine what, if anything, was moved or touched, who did the moving, and for what purpose.

Materials

- Writing utensil

Procedure

1. Read the crime scene report.
2. Use the Methodology Components Chart as you identify the methodology components of scene processing as they are represented in the report.
3. Use the Scene Integrity Issues Chart as you develop prevention strategies for the scene integrity issues found in the scene report.

Scene Report

On 09/10/2018, I, CSI G. Wyatt (#6505), was dispatched to 1301 Sound Garden Drive at approximately 8:30 p.m. to investigate an aggravated assault. I went en route at approximately 8:50 p.m. and arrived at approximately 9:35 p.m. Upon my arrival I spoke with Sgt. W. Hewitt (#220). He relayed the following information.

The victim, Lola French (w/f; dob: 12/04/1993), was in her residence cooking dinner and watching television. She heard a loud banging on her front door and thought the door was going to break. Scared, she ran into her bedroom and looked out the window, which has a view of the porch. From the bedroom window, she saw someone who appeared to be a white male. Visibility was poor as the porch light was not on, and there is no streetlight close to her residence to illuminate the area. The only light available was the outdoor ambient light from the night sky. Ms. French yelled at the male to leave and said she was calling 911. At that time, an object crashed through her bedroom window, and she ran out of the room into the interior of the residence. She dialed 911 but did not have a chance to speak as someone grabbed her from behind. Ms. French screamed for help and felt that she was being hit and her body twisted. She heard sirens, and at that time the male threw her into the living room wall. He opened the front door and ran out of the residence. Shortly thereafter, Officer M. Bandy (#4434) and Officer W. Nelson (#4415) entered the residence. They checked the residence and determined no one else was in the home; they called for EMS to respond. Ms. French was transported to St. Mary's Hospital as she was found to have been beaten severely and suffered a broken arm. Detectives were notified as was the crime lab to respond and process the scene.

After speaking with Sgt. Hewitt, I spoke with Detective H. Finn (#5501). Detective Finn stated that he and Detective J. Roberts (#5512) arrived at the residence at approximately 9:15 p.m. Upon their arrival, Ms. French was being placed on a gurney in preparation for transport. Detective Finn tried to speak with the victim, but she was very upset and crying. In efforts to comfort her, Detective Finn held her hand and told her she was going to the hospital for care. He assured her she was safe. After she was loaded in the ambulance, the detectives went into the residence. They noted there was blood in the living room, on the dining room floor, and in the bedroom. They noted the broken window in the bedroom and glass on the floor and throughout the room. They also observed blood on the windowsill and on the interior window frame. After walking through the residence, the detectives exited, waiting for crime scene investigators to arrive.

Finishing the briefing with Detective Finn, I noted an officer walking out of the residence. Officer D. Degner was in the area and stopped by to assist if needed. Officer Degner stated he walked into the residence and throughout it to observe. I noted Officer Degner's boots were making noise. It was discovered that pieces of glass were stuck in the tread of his boots. As this was evidence from the scene, I collected the boots, and Officer Degner left the scene. At that time, I requested Officer Bandy stand outside the residence with a Crime Scene Access Log to record anyone entering/exiting the residence.

Upon observing the residence, I noted it to be a one-story private residence that faced south and was on the north side of Sound Garden Drive. A concrete driveway led from the roadway north to the residence, which was composed of brown brick and white wood; the roofing was of dark brown shingles. An attached single-car garage was on the west side of the residence. At the front of the house, there was a covered porch. Next to the wood frame of the front door, there were numbers that identified the residence as 1301. The front door of the residence was closed, and there appeared to be dents near the bottom and in the approximate center. While examining the door, I observed red-colored stains on the porch floor. I followed the stains and noted there were some on the driveway and in the grass. These stains were similar to and consistent with a bloodstain trail. At that time, I decided to stop my visual assessment and retrieve evidence placards from my vehicle. While doing so, a light rain began to fall. Fearing I would lose evidence. I got some sterile swabs and distilled water from my vehicle and collected the stains on the driveway. As my first priority was preventing evidence loss, I did not document the stains prior to collection. After collecting the stain samples, I entered the residence to finish my visual assessment and walk-through. Entering the front door, I examined its interior side. I noted there were apparent bloodstains on the approximate center and near the top of the door. I also noted what appeared to be dried blood on the doorknob. Looking in the living room, I saw that the couches as well as the coffee table were in one corner of the living room. The east wall of the living room had what appeared to be bloodstains, and upon closer observation, there were what appeared to be a patent blood prints approximately 5 feet up from the floor. I walked into the kitchen and noted two pots on the stove. One had a red sauce in it, and the other was a pot of water. On the counter, I saw an open bottle of wine and a wine glass with a small amount of red liquid. I also observed two

cans of Diet Coke on the counter. From the kitchen, I entered the dining room. There was what appeared to be bloodstains on the floor, and there was an overturned vase of flowers on the dining room table. From the dining room, I entered a bathroom that was in order and unremarkable. I also walked into what appeared to be a guest room that was in order and unremarkable. At the end of a hallway on the west side of the house, I walked into the master bedroom. The light was on, and I could see broken glass on the floor and on the bed. Items on the dresser were on their side. The room was in disarray as if a struggle had occurred. I noted the window was broken, and there was apparent blood on the windowsill, the interior window frame, and the interior side of the window near the broken glass. Observing further, I saw what appeared to be a patent blood print on the east bedroom wall near the window frame.

After conducting a walk-through of the scene, I exited the residence and spoke with Detective Finn. I asked what the injuries of the victim were. He stated Detective Roberts was at the hospital and relayed that the victim had a broken arm and several cracked bones and ribs, but she did not sustain any bloodletting wounds. I then spoke with Officer Bandy concerning any actions in the residence prior to my arrival. He stated that he and Officer Nelson found Ms. French in the residence on the floor. They called for EMS and tried to keep the victim until aid arrived. When EMS arrived, attendants entered the residence and moved the furniture to one side of the room so there was enough space for them to work and bring the gurney into the residence. After the victim was placed on the gurney, she was taken outside to the ambulance; Officer Bandy closed the door of the residence behind him upon leaving. I asked Officer Bandy if he had seen any other indications of other persons in the residence. I relayed that in addition to a near empty wine glass there were two partially filled cans of Diet Coke on the counter. Officer Bandy stated that he later reentered the residence and saw Detectives Finn and Roberts in the kitchen drinking from Diet Coke cans. (I later spoke with Detective Finn, who stated that he and Detective Roberts had taken the drinks into the residence and forgot to remove them.)

After conducting the walk-through, gathering additional information, and completing the visual assessment, I deduced that the only person bleeding on scene was the suspect. Further, I conducted a presumptive blood test on one of the red stains, which resulted in a positive for blood. I further tested the red stain with a species of origin test that indicated the blood was human. I deduced the suspect had been injured when going through the broken window and deposited his blood in the residence and then outside the residence when he fled. As there were several officers still on scene, I requested they conduct a search and follow the blood trail for more evidence.

I documented the scene with video and digital photography. I then sketched the residence. I processed the exterior side of the front door for fingerprints but did not develop any. I collected samples of the apparent bloodstains on the windowsill for DNA comparison and submission into CODIS (Combined DNA Index System). I photographed the partial patent blood prints in the bedroom and living room; I then processed them with Leucocrystal Violet (LCV). The LCV enhanced the prints, and I was able to develop and then photograph an Automated Fingerprint Identification System (AFIS)–quality print.

As I was continuing the scene processing, Detective Finn informed me that he and several other officers followed the blood trail and found several items, including a lighter, bloodstained cigarette, and business card for Trixie's Tricks on Edward's Street.

I concluded processing the residence at approximately 12:45 a.m. I secured the evidence in my vehicle and then went en route to the hospital. I arrived at approximately 1:10 a.m. I went to the room of Ms. French, room #406, and took photographs of her injuries. I also collected the clothing she was wearing at the time of the incident. I left the hospital at approximately 2:00 a.m. and transported all evidence to the crime lab. I arrived at approximately 2:30 a.m. I secured all evidence in a lock box to await further examination. Two film media cards were submitted to the photo lab for processing.

End Report

G. Wyatt, Crime Scene Investigator

Absoroka County Sheriff's Office

Methodology Components Chart

Methodology Components	Scene Example
Knowledge	
Skills and tools	
Methodical approach	
Flexibility	
Coordinated effort	

Scene Integrity Issues Chart

Scene Integrity Issues	Prevention Strategy
Addition of material to the scene	
Destruction of material in the scene	
Movement of material in the scene	

Post Lab Questions

1. Why must crime scene processing be conducted using a systematic approach?
2. How might the integrity of a crime scene be compromised?
3. Discuss the importance of a coordinated effort when conducting a crime scene investigation.
4. What are the five major methodology components to successfully completing a crime scene investigation?

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Chapter 2

The Nature of Physical Evidence

Key Terms

Class characteristics
Cross-contamination
Individual characteristics
Individualization
Latent print
Locard's principle of exchange
Dermis
Epidermis
Loop
Whorl
Arch
Minutia
Rolled impressions
Plain impressions
Friction ridge skin
Positive control
Negative control
Mechanical fit

Learning Outcomes

1. Understand the different types of evidence that may be present at a crime scene.
2. Define class and individual characteristics.
3. Discuss contamination issues that may occur at a crime scene.
4. Understand the importance of Locard's exchange theory.
5. Demonstrate the ability to use mechanical fit.

2.1 Identifying Characteristics of Evidence

Objective

- Identify the categories in which evidence can be classified.
- Review examples of evidence and identify whether the characteristics for each are class or individual.

Concept Overview

Evidence recognition is a key component in crime scene processing, and it is important for crime scene personnel to understand the value associated with the items collected at a scene.

Items of evidence are generally divided into two categories: class characteristics and individual characteristics. Class characteristics are characteristics or traits of an item that are unique to a specific group and are not individualizing. For example, a shoeprint left by a female who wore size 8 shoes and a hair that came from a Hispanic male are class characteristics. Individual characteristics are traits or characteristics of an item that are specific or unique to that particular item. For example, the appearances and locations of tears, gouges, and cuts in a shoeprint left behind at a crime scene, which match those on the shoe collected from the suspect, are individual characteristics. Through examination or experimentation, individualization is established by linking together all the traits or characteristics of a specific item, allowing for exclusion of the items that do not match and inclusion of the items that originated from the scene.

There are several different disciplines of forensic science that can be used to analyze evidence. They are as follows:

Fingerprints	Fingerprints are the most common type of evidence sought at a crime scene. The ridge details and minutiae, located on the hands or feet of a person, yield individual characteristics.
Serological/biological	Serological/biological evidence is associated with the human body and is used in DNA analysis. These types of items could yield both class and individual characteristics.
	Examples: Bone, blood, semen, skin (epithelial cells), saliva.
Trace evidence	Trace evidence includes several different types of evidence, including hairs/fibers, glass, paints/polymers, soil, and gunshot residue.
	Hairs are a common form of trace evidence. Hairs can be distinguished by species, general location on the body, and in human cases, the general race (Caucasian, Negroid, and Mongoloid). Examination of the hair follicle includes its diameter, scales, medulla, pigment, and cortex. Hair generally exhibits class characteristics; however, in rare instances hair may exhibit individual characteristics.
	Fibers, like hairs, are categorized by the originating source. They may be manufactured, naturally occurring, or synthetic. A variety of microscopes are used to examine fibers. Fibers generally exhibit class characteristics.
	Glass is typically placed into three basic categories: glass type determinations, direction of force determinations, and sequence of force determinations. Type determinations evaluate known and unknown pieces of glass and try to determine if they have originated from a common source. Direction of force determinations assess the radial fractures present in the first concentric ring in an effort to conclude from which direction force was applied. Sequence of force determination evaluates conditions where multiple bullet defects are located in close proximity on the glass. When this occurs, it is necessary to note where the radial fractures meet and terminate, which may help establish a sequence or order to the shots. Glass exhibits class characteristics.
	Paints and polymers are encountered in a broad range of crime scenes. Paint is manufactured in a wide variety of types, with varying properties, and is used for different functions. Aside from color or basic type (latex, enamel, semigloss, etc.), the chemical composition, or ingredients of the paint, may offer a means of discrimination. Paint samples are the iconic form of trace evidence since there is rarely any left behind at a crime scene. Paint can exhibit both class and individual characteristics.
	Soils are a complex mixture of organic and inorganic compounds and can vary significantly in small areas. Examiners look for environmental contamination or unique environmental settings, which can help isolate the sample's approximate location. Soil evidence is a good example of a class characteristic.
	Gunshot residue (GSR) is discharged from a firearm and contains significant amounts of both burned and unburned residue. The residues can be tested in a variety of ways, both at crime scenes and in the laboratory. GSR exhibits class characteristics.
Firearms/ballistics	Firearms analysis involves the examination of weapons and any expended shell casings, bullets, or cartridges. These combined efforts aim to associate each item with the other, ultimately leading to an identification of a weapon and its discharge. Firearms evidence contains both class and individual characteristics.
Toolmark	Toolmarks are formed by the interaction of a tool with something in the crime scene. Three categories of marks are generally used. These include striations, compressions, and saw and drill markings. Striation marks are made when the tool comes into contact with an area and is slid against the target surface. A compression mark occurs when a tool is forced onto a soft material. Saw and drill marks occur when the tool is actually used on the target surface. Toolmark evidence presents both class and individual characteristics.

Impression	Impression evidence manifests itself at a crime scene in a variety of forms. Shoe and tire marks, bite marks, toolmarks (tools used on a malleable material), and plastic fingerprints (fingerprints that are left in a soft medium) are all good examples of impression evidence. Evidence of this nature can also be found as three-dimensional impressions (e.g., impressions located in soft dirt) or two-dimensional impressions (e.g., shoe marks deposited in grease on a hardwood surface). Impression evidence can manifest both class and individual characteristics.
Chemical	Chemical evidence is a unique form of evidence. Two types of analyses are generally conducted: drug analysis and toxicological analysis. Drug analysis is performed on items that are collected from individuals. For example, a bag of blue tablets is found in the trunk of a car. It would be necessary to determine if the pills were, in fact, a controlled substance. Toxicological analysis is performed when evidence is taken from an individual in the form of bodily fluids; the fluids are then subjected to analysis. For example, a person is pulled over for erratic driving, and a court order is issued to have his blood drawn. The results of the blood analysis would determine whether the person was over the legal limit. Chemical evidence can present both class and individual characteristics.
Document	Document analysis is used to determine if a document is a forgery, is a tracing, or has been altered in some other form. It can also be used to recover indented writings. It is most commonly encountered in economic crimes but can be seen in any type of crime scene where document-type evidence is present.
Computer and cell phone	Forensic computer analysis encompasses all aspects of hardware and software associated with computers. The analysis of these items allows for the tracking and media assessment of crimes such as hacking, fraud, and human trafficking/child-based crimes. Cellular phones are one of the most common types of digital evidence obtained at a crime scene. There is a lot of information that can be obtained from the individual's search/usage history as well as information from the service provider of the phones. Service providers can provide location and tower connectivity that can aid in criminal investigations.
Pathology	Forensic pathologists obtain additional training on trauma and pattern injuries that help assist them in determining the cause and manner of death. When doing this, they must consider the medical evidence as well as the context of the scene to aid in their determinations.

When handling evidence it is important to limit contamination. Contamination is the accidental transfer of biological or chemical components into an area. Cross-contamination is directly associated with Locard's exchange theory. The theory states that when two objects come into contact with each other, trace elements of each of the items are transferred to one another. It is important to wear personal protective equipment (PPE) such as gloves, masks, and/or booties to prevent this process from occurring.

Materials

- Paper
- Writing utensil

Procedure

1. Review all items presented.
2. Record on the Evaluation Worksheet what the item is and whether the item has class or individual characteristics, and provide a short explanation justifying your decision.
3. Complete the Post Lab Questions.

Evaluation Worksheet

Photograph: _____

Class Characteristic	Individual Characteristic	Justification

Photograph: _____

Class Characteristic	Individual Characteristic	Justification

Photograph: _____

Class Characteristic	Individual Characteristic	Justification

Photograph: _____

Class Characteristic	Individual Characteristic	Justification

Photograph: _____

Class Characteristic	Individual Characteristic	Justification

Photograph: _____

Class Characteristic	Individual Characteristic	Justification

Photograph: _____

Class Characteristic	Individual Characteristic	Justification

Photograph: _____

Class Characteristic	Individual Characteristic	Justification

Photograph: _____

Class Characteristic	Individual Characteristic	Justification

Photograph: _____

Class Characteristic	Individual Characteristic	Justification

Post Lab Questions

1. Give an evidentiary example for each of the following categories:
   Biological:
   Impression:
   Chemical:
   Firearms:
2. Why is it important to have a general understanding of the nature of evidence?
3. List three ways one could prevent contamination in a crime scene.
4. What is biological evidence? Why is it important?
5. How are drugs and toxicology the same? How are they different?

2.2 Evidence Processing

Objective

- Identify the processes to which specific items of evidence are subjected.
- Review examples of evidence and identify what type of analysis should occur.

Concept Overview

Evidence recognition is a key component in crime scene processing. It is also equally important to understand the processes that are associated with various types of evidentiary items. It is not uncommon for items to undergo multiple types of analysis to maximize their value to the investigation.

There are several different disciplines of forensic science that can be used to analyze evidence. They are as follows:

Fingerprints	Fingerprints are the most common type of evidence sought at a crime scene. The ridge details and minutiae, located on the hands or feet of a person, yield individual characteristics.
Serological/DNA	Serological/DNA evidence is associated with the human body and is used in DNA analysis. Examples: Bone, blood, semen, skin (epithelial cells), saliva.
Trace evidence	Trace examiners review a variety of evidentiary items. Trace items include hairs/fibers, glass, paints/polymers, soil, and gunshot residue. Hairs are a common form of trace evidence. Hairs can be distinguished by species, general location on the body, and in human cases, the general race (Caucasian, Negroid, and Mongoloid). Examination of the hair follicle includes its diameter, scales, medulla, pigment, and cortex. Hair generally exhibits class characteristics; however, in rare instances hair may exhibit individual characteristics. Fibers, like hairs, are categorized by the originating source. They may be manufactured, naturally occurring, or synthetic. A variety of microscopes are used to examine fibers. Fibers generally exhibit class characteristics. Glass is typically placed into three basic categories: glass type determinations, direction of force determinations, and sequence of force determinations. Type determinations evaluate known and unknown pieces of glass and try to determine if they have originated from a common source. Direction of force determinations assess the radial fractures present in the first concentric ring in an effort to conclude from which direction force was applied. Sequence of force determination evaluates conditions where multiple bullet defects are located in close proximity on the glass. When this occurs, it is necessary to note where the radial fractures meet and terminate, which may help establish a sequence or order to the shots. Glass exhibits class characteristics.

	Paints and polymers are encountered in a broad range of crime scenes. Paint is manufactured in a wide variety of types, with varying properties, and is used for different functions. Aside from color or basic type (latex, enamel, semigloss, etc.), the chemical composition, or ingredients of the paint, may offer a means of discrimination. Paint samples are the iconic form of trace evidence since there is rarely any left behind at a crime scene. Paint can exhibit both class and individual characteristics.
	Soils are a complex mixture of organic and inorganic compounds and can vary significantly in small areas. Examiners look for environmental contamination or unique environmental settings, which can help isolate the sample's approximate location. Soil evidence is a good example of a class characteristic.
	Gunshot residue (GSR) is discharged from a firearm and contains significant amounts of both burned and unburned residue. The residues can be tested in a variety of ways, both at crime scenes and in the laboratory. GSR exhibits class characteristics.
Firearms/ballistics/ toolmarks	Firearms analysis involves the examination of weapons and any expended shell casings, bullets, or cartridges. These combined efforts aim to associate each item with the other, ultimately leading to an identification of a weapon and its discharge.
	Firearms examiners, in many cases, also conduct toolmark analysis. Toolmarks are formed by the interaction of a tool with something in the crime scene. Three categories of marks are generally used. These include striations, compressions, and saw and drill markings. Striation marks are made when the tool comes into contact with an area and is slid against the target surface. A compression mark occurs when a tool is forced onto a soft material. Saw and drill marks occur when the tool is actually used on the target surface. Toolmark evidence presents both class and individual characteristics.
Drug analysis	Drug analysis is performed on items that are collected from individuals. For example, a bag of blue tablets is found in the trunk of a car. It would be necessary to determine if the pills were, in fact, a controlled substance.
Toxicology	Toxicological analysis is performed when evidence is taken from an individual in the form of bodily fluids; the fluids are then subjected to analysis. For example, a person is pulled over for erratic driving, and a court order is issued to have his blood drawn. The results of the blood analysis would determine whether the person was over the legal limit. Chemical evidence can present both class and individual characteristics.
Questioned documents	Questioned document examiners examine all documents. Documents are defined as any fixed method of communication between two or more persons. Many examiners are trained not only in handwriting analysis but also in computer forensics. Computer forensics personnel examine files contained in computer databases. Examples of document evidence include, but are not limited to, fake driver's licenses, forged birth certificates, e-mail communication, and suicide notes.
Computer and cell phone	Forensic computer analysis encompasses all aspects of hardware and software associated with computers. The analysis of these items allows for the tracking and media assessment of crimes such as hacking, fraud, and human trafficking/ child-based crimes.
	Cellular phones are one of the most common types of digital evidence obtained at a crime scene. There is a lot of information that can be obtained from the individual's search/usage history as well as information from the service provider of the phones. Service providers can provide location and tower connectivity that can aid in criminal investigations.
Pathology	Forensic pathologists obtain additional training on trauma and pattern injuries that help assist them in determining the cause and manner of death. When doing this, they must consider the medical evidence as well as the context of the scene to aid in their determinations.

Establishing evidentiary value is an important role as a crime scene technician and as an investigator. It is important to recognize the significance of each item, which is based on its ability to aid an investigation.

Materials

- Paper
- Writing utensil

Procedure

1. Review all items presented.
2. Record on the Evaluation Worksheet what the item is and what process(es) should be conducted. Use the Analysis Codes to complete the worksheet.
3. Complete the Post Lab Questions.

Evaluation Worksheet

Analysis Codes		
Trace = TR	Drugs = DR	Digital = DI
Serological/biological = DNA	Toxicology = TOX	Pathology = ME
Fingerprints = FP	Questioned documents = QD	
Ballistics/firearms/toolmarks = FA		

	Item Description	Analysis
Example	12 oz can of soda	DNA, FP
Example	Ransom note on light blue 8.5 × 11 paper	QD, FP
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Post Lab Questions

1. For items 1 and 2, justify your analysis selections.
2. Why is it important to maximize the value of evidence?
3. What is the primary goal of drug analysts?
4. Name three different types of biological evidence.

2.3 Mechanical Fit through Evidence Reconstruction

Objective

- Describe mechanical fit.
- Examine pieces of torn evidence for reconstruction and individualization of the evidence through mechanical fit.

Concept Overview

Mechanical fit, also known as a fracture match, is a unique form of evidence. When damaged or broken pieces of an object are in a scene, they may be reconstructed. These pieces should be carefully collected to prevent further breakage and preserved in their original form. When the item of origin is located, the pieces may be examined and matched back to the original object. This is known as mechanical fit/fracture matching, which is much like putting a puzzle together. Since the breaking action creates randomly sized and shaped pieces, the pieces being matched back to the item of origin can be viewed as individualizing evidence.

Materials

- Clean work area
- Glue or tape
- Writing utensil

Procedure

1. Examine the provided evidentiary pieces.
2. Lay the pieces out onto the workbook Reconstruction Canvas and glue the pieces together to visually demonstrate mechanical fit.
3. Complete the Post Lab Questions.

Reconstruction Canvas

Reconstruction Canvas

Post Lab Questions

1. What is mechanical fit?
2. Was using mechanical fit successful? Explain.
3. Describe each of the reconstructed evidentiary items.
4. How could mechanical fit be beneficial to an investigation?
5. Give an example of an item, other than paper, that could yield mechanical fit.

2.4 Evidence Collection and Packaging

Objective

- Identify the proper packaging techniques for various types of evidence.
- Review examples of evidence, and practice writing evidence descriptions and properly collecting the items.

Concept Overview

The proper collection and packaging of evidence is crucial to any investigation. Before the collection of any items of evidence within a crime scene, all documentation, including photographs, should be completed. The collector of the evidentiary items should always don proper personal protective equipment (PPE), and gloves should also be changed in between collection of each of the items of evidence. When at all possible, the entire item of evidence should be collected.

There are several different categories of evidence that may be encountered at a crime scene. The collection methods and packaging options should be determined through assessment of the evidence type.

Collection Methods

- Swabbing: One of the most common collection methods. Swabbing requires two sterile swabs, generally one wet and one dry. There are a variety of swabs on the market that include standard puritan cotton swabs and polyester swabs. Care should be taken to make sure the swabs are packaged in envelopes, swab boxes, or other paper-based packaging materials to ensure that the swab can dry. If the swab is not dry when packaged, bacteria and mold growth could possibly compromise the ability to move forward with laboratory processing.
- Cutting: Cutting is another method that may be employed to collect stains from specific items. A sharp clean instrument such as a razor, scalpel, knife, scissors, or other cutting instrument can be used. If multiple areas need to be cut, a new instrument should be used or the same instrument thoroughly cleaned to avoid cross-contamination.
- Scraping: Scraping is not commonly used for evidence collection but is sometimes necessary. A sharp, clean instrument such as a razor, scalpel, knife, or other cutting instrument can be used. Scraping is generally used when collecting paint samples from vehicles. This method should not be used for the collection of biological samples as this could cause bloodborne pathogens to become airborne, creating a risk of exposure and infection.
- Tape lifts: Tape lifts are often used to collect hairs and fibers from a crime scene. Using a piece of lifting tape, the tape should be placed over the area where the hairs and/or fibers are located. Once the tape is lifted from the surface, it should be placed on a piece of acetate/clear plastic. Hinge lifters may also be used for this process. Hinge lifters are clear adhesive sheets that contain a piece of cardstock attached to the edge. Once the lift is taken, the adhesive side can be placed directly onto the cardstock attached.
- Tweezers: Tweezers are used to collect small items of evidence such as hairs and fibers. It is recommended that plastic tweezers be used when collecting items of evidence. Metal tweezers can introduce additional markings to evidence, such as shell casings, and can be disposed of once used. This helps to limit cross-contamination.

There are a variety of packaging options when considering how to submit the evidence collected. The package should always be proportional to the item that is being collected. For example, placing a hair in a large paper sack could result in the hair not being able to be located. The more appropriate procedure is to place the hair in a druggist fold or small envelope for packing and submission.

There are a variety of collection methods. Some of the most common include:

- Cardboard boxes: Cardboard boxes are a strong, sturdy, and breathable packaging method. The cardboard construction makes it ideal for storing large/heavy items of evidence.
- Paper bags: The most common packaging method. Paper bags are breathable and come in a variety of sizes. They are strong and durable for most items of evidence.
- Envelopes: There are two types of envelopes commonly used when packaging evidence: paper envelopes and glassine envelopes. They are both available in various sizes for packaging evidence. Paper envelopes are a breathable package that is excellent for packaging for biological evidence. Glassine envelopes are air, water, and grease resistant. They are good for packaging documents, trace items of evidence such as hairs and fibers, and drugs.
- Airtight containers: Metal cans are a good example of airtight containers. These are generally used when collecting evidence from arson scenes that contain possible accelerants.
- Glass vials: Glass vials are used for collecting volatile chemical and liquid evidence.
- Plastic bags: Caution should be used when selecting this packaging method. They are available in a variety of sizes, and they are typically used for money collection or temporarily holding personal property. They may also be used as temporary packaging for wet items collected at a crime scene for transportation back to the laboratory for drying. Long-term storage using plastic bags should be avoided when collecting biological evidence or evidence that is wet in nature. They do not allow moisture to be released, thus promoting mold/bacteria growth.

The proper labeling and sealing of an item of evidence is important as this helps to identify the items that have been collected. A thorough description of the item being collected should be documented on the exterior of the package. The item's description should be as specific as possible and include the color, make, model, construction, manufacturer, size, quantity, condition, identifying features, etc. The location from where the evidence was collected should also be noted, for example, right arm of the Bonita Springs blue microfabric sofa in the living room.

The item should also be assigned a unique identifier. This unique identifier helps the technician to recognize the item as the one collected from the scene. Generally, this unique number is a numerical number as well as the collector's initials, for example, CF1 or CF01. In some instances, it may be necessary for the collector to use letters to designate multiple parts of an item, for example, CF1a and CF1b, in order to designate that item 1 has two parts.

When labeling an item for identification, the package must contain certain information. The information at a minimum should contain the agency's name, type of offense, case number, name/initials/employee or badge number of collector, evidentiary item number, date of collection, time of collection, description of the item of evidence, and location from where the item was collected.

Utilizing a proper seal helps to maintain the integrity of the evidence as well as preventing loss and cross-contamination. According to the American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB), "a package is properly sealed if entering the package requires obvious damage to the container or the seal itself. The seal must be sufficient to prevent loss or contamination of the item(s) contained in the package without sealing or altering it." It is recommended that the tape cross the flap for a bag, and that the ends should extend past the edge of the bag and be folded back to fully seal the flap. The collector's initials, employee/badge number, and date should cross the seal and the bag (Figure 2.1).

Materials

- Paper
- Writing utensil

Procedure

1. Review all items presented.
2. Complete the Evaluation Worksheet by writing a description of the item(s) presented; note the collection method and justification for the decisions on packaging.

Figure 2.1
Properly sealed evidence bag.

3. Once the Evaluation Worksheet has been completed and the item packaged, present it to the instructor for review.
4. Complete the Post Lab Questions.

Evaluation Worksheet

Category of Evidence	Collection	Packaging
☐ Fingerprint	☐ Entire item	☐ Cardboard box
☐ Biological	☐ Swab	☐ Paper bag
☐ Computer/digital	☐ Cut	☐ Plastic bag
☐ Trace	☐ Scrape	☐ Envelope
☐ Firearms/ballistics	☐ Tape lift	☐ Glass vial
☐ Impression	☐ Tweezers	☐ Other (explain)
☐ Chemical	☐ Other (explain)	
Justification:		
Instructor Only		
☐ Type of evidence	☐ Collection method	☐ Packaging method
Comments:		

Category of Evidence	Collection	Packaging
☐ Fingerprint	☐ Entire Item	☐ Cardboard Box
☐ Biological	☐ Swab	☐ Paper Bag
☐ Computer/Digital	☐ Cut	☐ Plastic Bag
☐ Trace	☐ Scrape	☐ Envelope
☐ Firearms/Ballistics	☐ Tape Lift	☐ Glass Vial
☐ Impression	☐ Tweezers	
☐ Chemical		
Justification:		
Instructor Only		
☐ Type of evidence	☐ Collection method	☐ Packaging method
Comments:		

Category of evidence	Collection	Packaging
☐ Fingerprint	☐ Entire item	☐ Cardboard box
☐ Biological	☐ Swab	☐ Paper bag
☐ Computer/digital	☐ Cut	☐ Plastic bag
☐ Trace	☐ Scrape	☐ Envelope
☐ Firearms/ballistics	☐ Tape lift	☐ Glass vial
☐ Impression	☐ Tweezers	
☐ Chemical		
Justification:		
Instructor Only		
☐ Type of evidence	☐ Collection method	☐ Packaging method
Comments:		

Category of Evidence	Collection	Packaging
☐ Fingerprint	☐ Entire item	☐ Cardboard box
☐ Biological	☐ Swab	☐ Paper bag
☐ Computer/digital	☐ Cut	☐ Plastic bag
☐ Trace	☐ Scrape	☐ Envelope
☐ Firearms/ballistics	☐ Tape lift	☐ Glass vial
☐ Impression	☐ Tweezers	
☐ Chemical		
Justification:		
Instructor Only		
☐ Type of evidence	☐ Collection method	☐ Packaging method
Comments:		

Post Lab Questions

1. Based on the items below, note the packaging that should be used. Justify your answer.
   a. Liquid blood
   b. Handwritten ransom note
   c. Baseball bat
   d. Strands of hair
2. What information should be documented when labeling an item of evidence?
3. Give an example of when a tape lift would be used for evidence collection.
4. Why is sealing the packaging of an item of evidence important?

2.5 Chain of Custody

Objective

- Understand the purpose of a chain of custody.
- Practice completing documentation pertaining to chain of custody.

Concept Overview

Chain of custody is the chronological documentation of an item of evidence. It records who was in possession of the evidence from the time it was collected until it is admitted into court as evidence. Each time the evidence is moved from a location or person to another, it must be logged on the chain of custody. There are two different ways to track this; one is utilizing a paper-based form, and the other is using a more technology-based form, such as a bar coding system.

At a minimum, the documentation should contain the agency's name, type of offense, case number, name/initials/employee or badge number of collector, evidentiary item number, date of collection, time of collection, description of the item of evidence, and location from where the item was collected. When describing the item being collected, you should document this on the exterior of the package. The item's description should be as specific as possible and include the color, make, model, construction, manufacturer, size, quantity, condition, identifying features, etc. The location from where the evidence was collected from should also be noted.

The item should also be assigned a unique identifier. This unique identifier helps the technician to recognize the item as the one collected from the scene, and is reflected throughout the documentation process, such as on evidence log forms and photographs. Generally, this unique number is a numerical number as well as the collector's initials, for example, CF1 or CF01. In some instances, it may be necessary for the collector to use letters to designate multiple parts of an item. For example, CF1a and CF1b, in order to designate that item 1 has two parts.

Materials

- Paper
- Writing utensil

Procedure

1. Review the scenarios presented and complete the chain of custody form.
2. Complete the Post Lab Questions.

Evaluation Worksheet

Scenario 1

Case no.: 98-101179 Offense: Burglary of a residence

Agency: Sun Valley Police Department

Crime Scene Investigator Mindy Smith responds to a crime scene at 11:30 a.m. on April 5, 2018. While on scene she collects a red and metal flathead screwdriver that was located beside the broken front door frame on the porch of the residence. She labels the item MS01 and completes the collection at 12:15 p.m. She secures the screwdriver for transport back to the laboratory for processing. Once at the laboratory, she submits the item of evidence to Tina Wolff, property room technician, at 1:39 p.m. At 9:30 a.m. on April 6, 2018, latent print examiner Cynthia Jones retrieves the item from Tina Wolff.

Agency:	Case no.:	Type of offense:	
Item no.:		Time of collection:	Date of collection:
Collected by:			
Description of evidence:			
Location of collection:			
CHAIN OF CUSTODY			
Collector		Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time
Released by:	Released To:	Date	Time

Scenario 2

Case no.: 79-171018 Offense: Robbery
Agency: Walker Co. Sheriff's Office
Detective Sean Abells is working a crime scene and collects a DNA swab from a green XL men's shirt located on the floor near the entrance of the business. He properly packages the swab, labels it as SA01, and records the time as 2:15 p.m. While completing the scene, he is notified that he needs to depart immediately for another crime scene located across the county. Sean's supervisor, Christopher Dixon, offers to drop the swab off at the lab for him. Sean thankfully agrees and gives the DNA swab to his supervisor at 2:31 p.m. Christopher secures the item for transport back to the laboratory. He arrives at the lab at 3:55 p.m. Once at the lab, he goes to the DNA unit and gives the sample to DNA Analyst Stephanie Oliver, who takes possession of the swab at 4:05 p.m.

Agency:	Case no.:	Type of offense:	
Item no.:		Time of collection:	Date of collection:
Collected by:			
Description of evidence:			
Location of collection:			
CHAIN OF CUSTODY			
Collector		Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time
Released by:	Released to:	Date	Time

Post Lab Questions

1. What is a chain of custody?
2. Why is a chain of custody important?
3. What happens if an item does not contain a chain of custody?

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Gardner, Ross M., and Donna R. Krouskup. 2018. *Practical Crime Scene Processing and Investigation*. 3rd ed. Boca Raton, FL: CRC Press.

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James, Stuart H., and James J. Nordby. 2009. *Forensic Science: An Introduction to Scientific Investigative Techniques*. Boca Raton, FL: CRC Press.

Chapter 3

Actions of the Initial Responding Officer

Key Terms

Initial responding officer
Primary focal points
Secondary scenes
Natural entry and exit points

Learning Outcomes

1. Understand the importance of being the first responding officer.
2. Identify primary focal points and natural entry and exit points.
3. Recognize the value associated with secondary scenes.

3.1 Creating a Crime Scene Control Log

Objective

- Understand the importance of crime scene security.
- Understand the importance of crime scene integrity.
- Practice creating a formal Crime Scene Control Log.

Concept Overview

The initial responding officer is a key player in keeping and maintaining the crime scene until all other personnel arrive. Their main objectives should be to:

1. Document the provided information.
2. Not become a casualty.
3. Provide for emergency care.
4. Secure and control the scene, including all persons within it.
5. Release the scene to the appropriate authorities. (Usually this will be the investigating detective and/or crime scene personnel.)

Documenting the initial information is an important step in verifying the information relayed from dispatch and in taking down basic scene information. This can include but is not limited to:

1. Case number
2. Address of the incident

3. Type of crime/call
4. Arrival/departure times
5. Complainant/victim/eye witness/suspect information
6. Personnel entering and leaving the scene and the reason they are there

Confirming and documenting this information allows the initial responding officer to have a solid foundation when moving forward in the scene.

Officer safety is important in any investigation. Many times, officers rush into a scene and, in their desire to improve the situation, do not consider the threats or dangers that may lie just around the corner. When gauging officer safety, three specific areas should be considered:

1. Is the crime still in progress and are there suspects on scene?
2. Are there natural hazards present that can inhibit or harm the first responder?
3. Are there man-made hazards present that can endanger first responders?

Once these areas have been addressed, officers can proceed more cautiously and effectively into a scene.

Emergency care is generally administered by Emergency Medical Services (EMS) personnel. In crimes involving an injury or death, an additional factor to consider is controlling the life-saving activities and medical personnel who respond. While police agencies mandate evidence preservation, *life-saving always takes priority over evidence preservation*. If the initial responding officer arrives before EMS, the officer must take steps to aid the victim. If the responding officer is not participating in the life-saving actions, the officer can direct the medical and other personnel entering the scene in ways that will best preserve the scene.

Once the scene is safe, and life-saving activities are underway or completed, the initial responding officer must try to secure and control the crime scene. Since every crime scene is different, several factors should be considered when deciding where to establish the perimeter:

1. Is there a primary focal point?
2. Is there a natural entry or exit point?
3. Is there a secondary scene? Could it be possible that a secondary scene exists?

The primary focal point is the easiest to detect. This is the area an officer will naturally gravitate toward upon arrival at the scene. Generally, these areas include a body lying on the floor in the middle of a room or, in the case of a burglary, a ransacked living room. The natural entry or exit points are also of particular interest in a crime scene. Perpetrators must enter and leave a scene in some manner, such as entering by breaking in and exiting by driving away. Oftentimes, these areas are rich in evidentiary value and should be noted. For example, possible evidence includes blood evidence, fingerprint impressions, trace evidence, and tire or footwear impressions. By linking the natural focal point with the entry and exit points, the officer can isolate the areas included in the primary scene.

A potentially significant issue is overlooking secondary scenes. Such areas may include staging areas, areas where goods were loaded up to be used in the commission of the crime, or areas where items were deposited after the crime took place. These areas are often located in close proximity to the scene and/or along avenues of entry or exit.

Eventually the investigating detective and/or crime scene personnel will arrive to assume responsibility of the scene. The releasing of the scene could take minutes or hours. This is an opportune time for the initial responding officer to make notes regarding the scene and to note their own observations and actions upon arrival at the scene. It is imperative that the initial responding officer be debriefed by the investigative personnel at the scene before responding to their next call or scene.

Materials

- Paper
- Writing utensil
- (Alternate) Computer/word processing software

Procedure

1. Examine the Data Table of provided category terms and create a template for a Crime Scene Control Log.
2. When satisfied with the template, create a formal log.
3. Complete the Post Lab Questions.

The data table contains the category terms to be used in creating a Crime Scene Control Log template and formal document.

Data Table

Date	Time Out	Form Creator
Location Address	Reason at Scene (additional personnel)	Name/Unit/Agency
Case Number	Time In	Offense

Post Lab Questions

1. What is the purpose of a crime scene log?
2. What items should be included in the log?
3. Why is debriefing important?
4. Define and give an example of a primary focal point.
5. Is the primary focal point or the natural entry and exit points the most important to preserve? Why?

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Gardner, Ross M., and Donna R. Krouskup. 2018. *Practical Crime Scene Processing and Investigation*. 3rd ed. Boca Raton, FL: CRC Press.

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Chapter 4

Processing Methodology

Key Terms

Assessing
Observing
Documenting
Searching
Collecting
Processing/analyzing
"Going back"

Learning Outcomes

1. Identify the six basic activities related to crime scene processing.
2. Identify, in order, the sequence of each activity.
3. Understand the process of "going back."
4. Recognize the eight-step descriptive set.

4.1 Utilizing a Descriptive Set in Evidence Documentation

Objective

- Describe the basic activities upon discovering evidentiary items.
- Describe the eight-step descriptive set used to document evidence.
- Practice using the eight-step descriptive set on items of evidence.

Concept Overview

Crime scene processing is accomplished through the following basic activities: assessing, observing, documenting, searching, collecting, and processing/analyzing.

Assessing begins the task of processing and defines which procedures will be used. One should be continuously assessing the crime scene as it is processed. It is important for crime scene personnel to keep on assessing the scene and adjusting the processing plan when necessary.

Observing involves evaluating and mentally registering the condition of the scene and items located within it. It is important to remember that observing does not always mean moving through the scene in an intrusive manner. Crime scene personnel often remain at a single location to observe and refrain from moving through the scene, as their movement may disturb or damage valuable physical evidence.

Documenting is a critical component in crime scene processing and includes numerous activities, such as recording the crime scene personnel's observations, photographing and videotaping the scene and its evidence, and creating crime scene sketches. These activities range from nonintrusive (taking overall photographs) to very intrusive (taking measurements for a crime scene sketch). It is important to make sure that the initial documentation of the scene captures the scene *in situ*, or as is, before any significant scene alterations occur. When documenting the scene, it is important to detail each item located at the scene. An eight-step descriptive set may be used to complete this task. The eight steps include:

1. Quantity: Number of item(s) placed in packaging container
2. Item: Common name of article in packaging container
3. Color: Use primary colors for description and/or the color descriptor on the item itself
4. Type of construction: What the item is made of and/or how it is put together
5. Approximate size: The physical size of the item
6. Identifying features: Anything that makes the item unique
7. Condition: The cosmetic appearance of the item
8. Location: Where the item was located within the scene

An example of an evidentiary item description is as follows: one Adidas black and white leather shoe, approximately 14 inches in length, three black scuff marks approximately 1.5 inches in length on the toe of the shoe, located in the master bedroom closet floor.

Searching the scene ranges from visually examining the scene to moving items within the crime scene to better observe their surfaces. Because of the intrusive nature of this task, it is important that all initial documentation be completed before continuing with a more intrusive and disruptive search.

Collecting is the physical collection of items within the crime scene. Such items can include trace evidence, blood evidence, impression evidence, or objects/items at the scene that contain these types of evidence. Structural objects, such as pieces of flooring and walls, may also be collected if they contain some or all of the aforementioned evidence. Always remember that once an item is removed from the scene, the scene is forever altered.

Processing the scene involves the use of powders and/or chemicals in order to develop, enhance, or make visible items of evidence. Black powder, magnetic powder, and superglue fuming are all examples of techniques that can be used to develop latent prints. In regard to potential blood evidence, presumptive tests such as phenolphthalein or tetramethylbenzidine (TMB) may be employed as a screening process prior to utilizing blood development and enhancement chemicals, such as amido black and luminol. In some situations, it may be necessary to use more than one development technique. It is the responsibility of the crime scene technician to consider which methods can and will be used in order to determine the sequence in which they need to be employed. This knowledge is the result of training and experience. Ultimately, each item of evidence will be submitted for some form of analysis, and each piece will be used to determine a sequence of events that took place within the scene.

"Going back" is an integral part of crime scene processing and is a common and necessary occurrence. The farther one progresses into the processing of a scene, the more likely it is that personnel will encounter items that were not previously observed or considered to have probative value. As a result, new items of evidence are routinely discovered. When this occurs, the investigator/technician must cease their current step and return to an earlier one, such as documentation, in order to deal with the newly discovered evidence. This process will occur throughout the entire scene processing event and will end when no more evidence or potential evidence is observed.

Now that the basic processing activities have been identified, the question an investigator may ask is, "How do I apply them to a scene?" or "Is there a particular order or sequence in which these activities should be conducted?" There is no one correct way to process a scene. There is no single sequential template that can be used to investigate and process every scene, because all scenes have unique circumstances and characteristics. Variation will occur in the following:

- Location (indoors vs. outdoors)
- Environmental characteristics

  - Outdoors: Rain, wind, extreme temperatures
  - Indoors: No ventilation, no electricity
- Condition of decedent
  - Advanced decomposition
  - Dismemberment
  - Fire damage
- Evidence processing/collection (type and extent)
  - Trace evidence
  - Fingerprint/friction ridge processing
  - Blood evidence
  - Chemical processing/enhancement
  - Impression casting

Even though such variation will always be encountered, it is imperative that investigators and technicians use some type of methodology in their investigations. A methodology is the procedure by which one conducts an activity. Use of a methodology in scene investigation and processing will necessarily cause the investigative event to be more focused and thereby more efficient. Focus and efficiency will increase the quality of every aspect of an investigation. This is certainly not to say that one is locked into the sequence outlined in a given methodology. On the contrary, investigators must be flexible and adaptable as scene investigations are fluid and dynamic. Typically, there is movement among the steps or processes within a methodology. An investigative methodology developed by the U.S. Army Criminal Investigation Command is offered as an example:

Step 1: Initial Notification

This information concerns who contacted the investigator, when contact was made, the type of scene reported, and who made the report.

Step 2: Coordination, Assessment, and Team Callout

This step involves confirming the jurisdiction of the scene, assessing the scene after arrival, and determining whether additional investigative personnel will be needed for the scene investigation.

Step 3: Conduct Initial Observations

The investigator conducts an initial scan of the scene. Fragile evidence observed is immediately collected to prevent loss. Otherwise, focal points or central theme items such as a decedent or weapon are visually searched for to gain an overall impression of the scene.

Step 4: Deal with the Deceased

An inquest or investigation by a medical examiner or justice of the peace should be conducted in all instances of questioned death. An investigator must find out the specific actions carried out during such inquests and document them. Movement of the decedent, or inadvertent repositioning of the decedent or decedent's clothing, can affect theories generated concerning actions within the scene. This information must be obtained from emergency service personnel if attempted aid was administered.

Step 5: Photograph the Scene

The scene is documented with video and photography. Photographs should be of three ranges: overall, medium range or evidence establishing, and close-up.

Step 6: Document Overall Observations

The eight-step descriptive set listed previously is used to obtain detailed information of the scene and its evidence. At this point, the observation is done visually. Objects or items of the scene are not touched or moved, as the evidence within the scene has not been plotted and sketched yet.

Step 7: Sketch the Scene

A rough or preliminary sketch is created to document the dimensions of the rooms and furniture at the scene. Evidence is also plotted or fixed within the scene using measurements obtained through one of several mapping methods. Accurate measurements sometimes require the movement of items within the scene; therefore, sketching is a task conducted after photography.

Step 8: Conduct a First Recheck

The scene is observed visually for items that may have been missed up to this point in the investigation.

Step 9: Release the Body

Prior to movement of the decedent for transport, thorough observation and visual examination must be conducted for fragile evidence or evidence that may be altered during transport. Such evidence should be documented and collected.

Step 10: Collect Items of Evidence

Items identified as evidence are moved and evaluated for other types of evidence, such as trace evidence or blood evidence. If found, the evidence is photographed and collected for analysis. All items should be collected and properly packaged.

Step 11: Conduct a Second Recheck of the Scene

Now that all identified evidence has been collected, the investigator can begin processing for fingerprints, utilize an alternate light source (ALS) to search for biological fluids, and move and turn over items in search of additional physical evidence.

Step 12: Conduct a Third Recheck of the Scene

This involves confirming that no areas of the scene have been overlooked in the searching process. More complex techniques, such as chemical enhancement and trajectory analysis, are conducted.

Step 13: Check Beyond the Scene

The scene perimeter and outlying areas are rechecked to confirm that no evidence has been overlooked.

Step 14: Conduct an On-Scene Debriefing of the Investigative Team

Prior to releasing the scene, team members ensure that all documentation has been collected and any investigative questions concerning the scene have been answered, if possible.

Step 15: Release or Secure the Scene

The scene is to be released to the appropriate person, and once released, the scene cannot be captured again without a warrant or consent.

Step 16: Process and Package Evidence

In a controlled environment, the investigator/technician ensures that all evidence is properly packaged for preservation.

Step 17: Conduct a Formal Debriefing

Case agents review the investigation and consider working theories based on the information obtained.

This 17-step methodology is quite extensive and is typically utilized in its entirety when major crime scene investigations, such as homicide, are conducted. Nonetheless, any crime scene may be investigated by employing this methodology. It may be necessary, however, to exclude unnecessary steps.

Materials

- Writing utensil

Procedure

1. Examine the evidentiary items provided by the instructor.
2. In the Data Worksheet, document each item using the 8-step descriptive set.
3. Complete the Post Lab Questions.

Data Worksheet

8-Step Descriptive Set	
Quantity	
Item	
Color	
Type of construction	
Approximate size	
Identifying features	
Condition	
Location	

8-Step Descriptive Set	
Quantity	
Item	
Color	
Type of construction	
Approximate size	
Identifying features	
Condition	
Location	

8-Step Descriptive Set	
Quantity	
Item	
Color	
Type of construction	
Approximate size	
Identifying features	
Condition	
Location	

8-Step Descriptive Set	
Quantity	
Item	
Color	
Type of construction	
Approximate size	
Identifying features	
Condition	
Location	

8-Step Descriptive Set	
Quantity	
Item	
Color	
Type of construction	
Approximate size	
Identifying features	
Condition	
Location	

8-Step Descriptive Set	
Quantity	
Item	
Color	
Type of construction	
Approximate size	
Identifying features	
Condition	
Location	

Post Lab Questions

1. What are the six basic steps associated with crime scene processing?
2. What eight elements are associated with the descriptive set?
3. What is the purpose of observing?
4. Do you always have to walk through a crime scene to observe?
5. Give an example of "going back" at a scene.
6. Why is it important to make sure that you have completed initial documentation before moving forward?
7. If an item at the scene is "bumped," unintentionally moved, can one just put it back? Why or why not?

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Gardner, Ross M., and Donna R. Krouskup. 2018. *Practical Crime Scene Processing and Investigation*. 3rd ed. Boca Raton, FL: CRC Press.

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Chapter 5

Assessing the Scene

Key Terms

Biohazard
Circle or spiral search
Grid search
Scene security
Strip and line search
Zone search
Team approach: area
Team approach: function

Learning Outcomes

1. Understand each of the crime scene searching techniques.
2. Define area and function team approaches.
3. Recognize common biohazards.

5.1 Establishing Crime Scene Perimeters

Objective

- Understand the purpose of crime scene perimeters.
- Describe the function of the inner scene perimeter and outer scene perimeter.
- Examine crime scene figures and practice establishing crime scene perimeters.

Concept Overview

The basic goal of scene processing is to collect as much evidence as possible in the best condition as possible. The best way to preserve the integrity of the evidence is to produce a multilevel isolation.

The initial crime scene perimeter is likely to consist of a single barrier established by the initial responding officer (Figure 5.1). Its placement is based on observations made at the scene involving the primary focal point and entry and exit points. The primary focal point is the area an officer will naturally gravitate toward upon arrival, such as the location of a decedent or a weapon. The natural entry or exit points are rich in evidentiary value and should also be protected. Such areas can contain trace evidence, impression evidence, or blood evidence of the suspect(s). By linking the natural focal point with the entry and exit points, the officer has isolated areas of evidentiary value for the investigator. Crime scene barriers are put into place using a variety of methods. Crime scene tape, law enforcement personnel/vehicles, and natural boundary lines such as a river/stream or heavily wooded area are all means of providing a barrier for a crime scene.

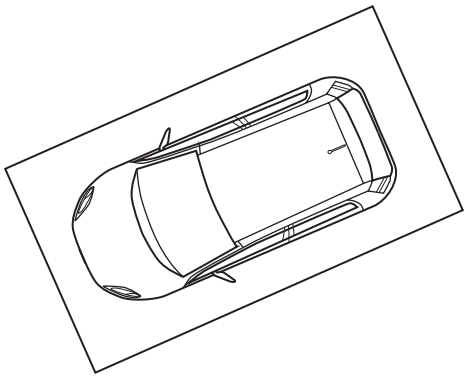

Figure 5.1
Initial scene perimeter.

Even though the initial responding officer has established an initial perimeter to protect the scene, crime scene personnel and investigators must conduct an independent evaluation of the entire scene. A decision must be made to either maintain the established initial perimeter or create a larger or smaller inner barrier (Figure 5.2).

After establishing the inner perimeter, another assessment should be made to determine whether the establishment of an outer perimeter is warranted. Characteristics of the physical scene affect this decision. For example, is the scene located in a secluded, rural area or in a highly populated, urban area? The number of personnel on location is also a factor. An outer perimeter may be necessary to isolate the scene and the investigators working in it. The second barrier should be far enough away to control onlookers and the media, while giving enough room in between the initial and secondary barriers for officers and crime scene personnel to gather. This "buffer zone" should be used as a work area, and also provides a physical buffer between the actual scene and unauthorized individuals.

Secondary scenes should also be considered when assessing the crime scene for security issues. Before or after the commission of the crime, staging areas or areas where goods may have been loaded, stored, or discarded could contain evidence that is pertinent to the case. It is important for officers and crime scene personnel alike to consider secondary scenes when establishing crime scene barriers.

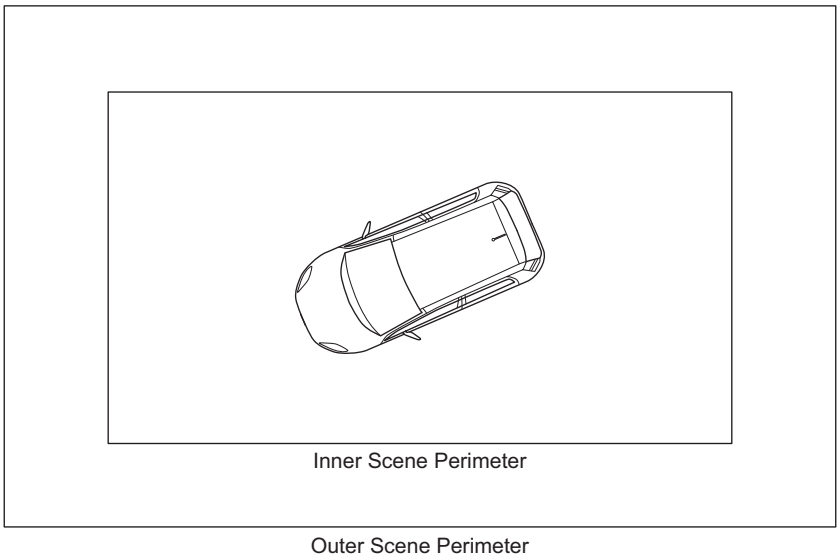

Figure 5.2
Established inner and outer perimeter.

In any attempt to search and/or process a crime scene, all personnel involved need to be conscious of biohazard risks that may be present. Hazards come in a variety of forms. Structural hazards may be found in fire or explosion scenes. Chemical or inhalation hazards from fire scenes or natural gas leaks may also be present. Biological biohazards are often the product of the crime itself and are seen in the form of blood, fecal matter, urine, vomit, dirty needles/syringes, etc. These hazards, if precautions are not taken, could lead to exposure to HIV; hepatitis A, B, and/or C; or any other serious illness and possibly death. It is important to make sure all personal protective equipment (PPE) is in place, including, but not limited to, masks/breathing apparatus, gloves, booties, Tyvek suits, and eye protection.

Materials

- Writing utensil

Procedure

1. Examine the provided crime scene diagrams.
2. For each figure, draw an inner perimeter based on:
   - Primary focal points
   - Natural entry and exit points
   - Secondary scenes

   Identify and describe each of these elements in the Data Worksheets.
3. For each figure, draw an outer perimeter if necessary, and indicate on the diagram the locations of the following:
   - Crime scene investigators
   - General law enforcement personnel
   - Administration staff
   - Media
   - Onlookers
4. Complete the Post Lab Questions.

In the Data following Worksheet, indicate the specific characteristics present in the scene that affected the creation of the inner and/or outer perimeter. This information should support the location and boundaries of the inner and/or outer perimeter.

Data Worksheet

Scene Scope	Scene Characteristic(s)
Primary focal points	
Natural entry and exit points	
Secondary scenes	

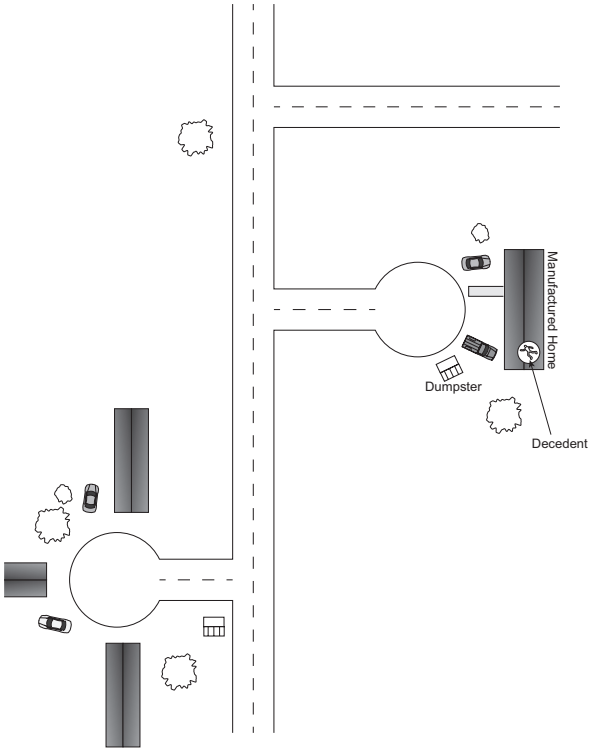

Figure 5.3
Rural neighborhood.

Data Worksheet

Scene Scope	Scene Characteristic(s)
Primary focal points	
Natural entry and exit points	
Secondary scenes	

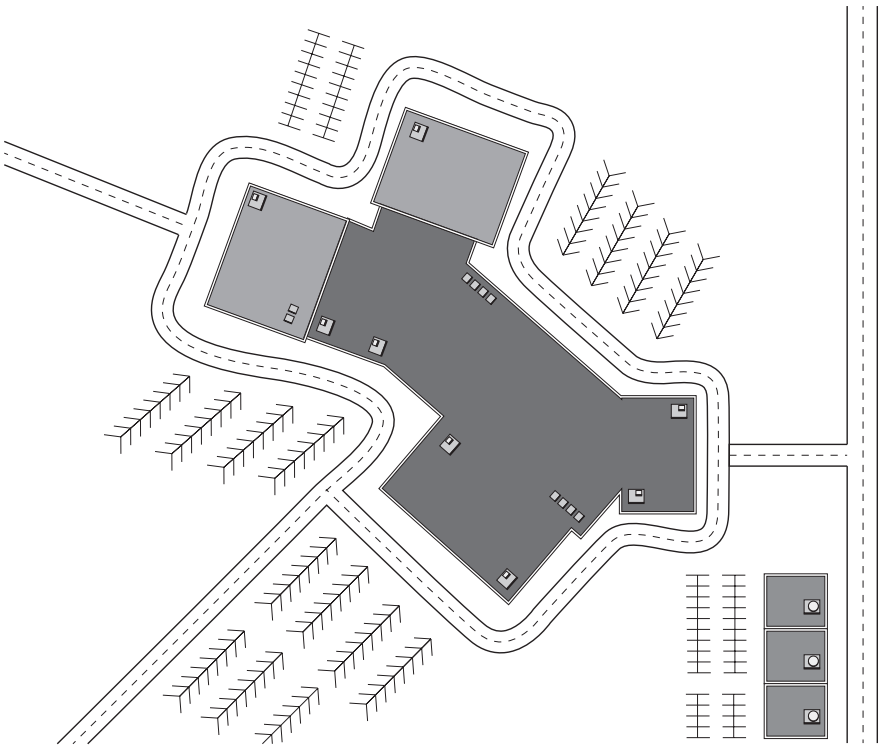

Figure 5.4
Retail center.

Data Worksheet

Scene Scope	Scene Characteristic(s)
Primary focal points	
Natural entry and exit points	
Secondary scenes	

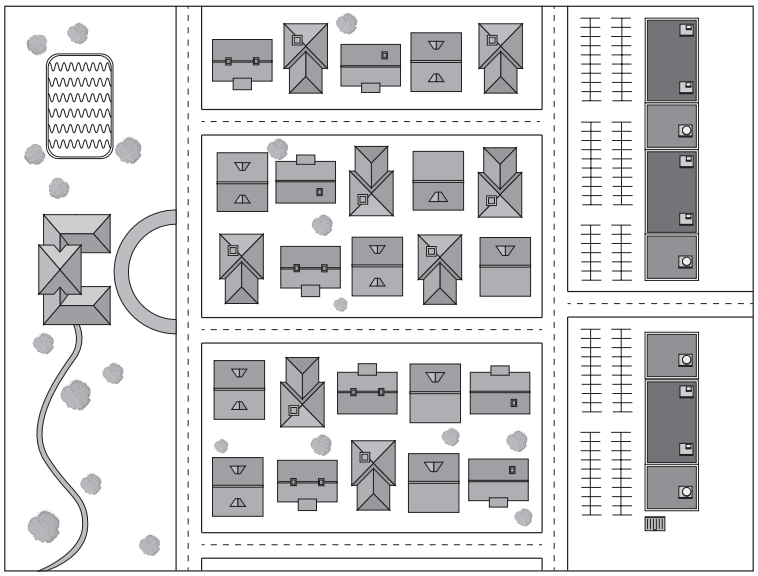

Figure 5.5
Urban neighborhood.

Post Lab Questions

1. What is the purpose of an initial crime scene barrier? Who is generally responsible for putting up this barrier?
2. Why is a secondary barrier important?
3. When looking at the diagrams, was it easy or difficult to determine where to draw the crime scene barriers? Why or why not?
4. Who is generally located in the buffer zone between the two crime scene barriers?

5. What are some disadvantages of using a natural barrier?

5.2 Conducting Crime Scene Searches

Objective

- Describe the five basic crime scene search patterns.
- Practice conducting crime scene searches.

Concept Overview

Searching the scene is required to locate present evidence. The specific method chosen will vary based on the team composition and the location/area of the scene. It is important to be methodical and systematic when searching the scene. Methodical refers to the order or systematic behavior related to searching the scene. Systematic refers to being purposefully regular, which helps eliminate overlooking key evidentiary items. The combination of being methodical and systematic ensures that the searcher or searchers have thoroughly covered the area to the best of their ability. Several things are taken into consideration when determining which search method to use:

1. Nature of the ground being covered
2. Lighting conditions
3. On-scene environmental conditions
4. Size of the item being searched for

Scene searches may also be conducted by a single searcher or multiple searchers depending on the area that needs to be searched. When a team is required, it is important to select a specific approach, either by area or by function. The area approach is where a single team handles all activities associated with processing the scene. The function approach is when a team leader designates different groups of people to do different activities at the scene. Whether by area or by function, it is of vital importance to establish a plan for processing the scene.

While there are many different types of search methods, this activity will concentrate on four:

1. Circle/spiral search
2. Strip/line search
3. Grid search
4. Zone search

A circle or spiral search is a useful method when searching interior scenes. The searcher begins from the outside perimeter and then, moving in a circular motion, works inward toward the middle of the scene, making a spiral pattern. This technique can also be conducted in the reverse, beginning at the interior of the scene and working toward the perimeter in a spiral pattern. Whether moving inward or outward, it is important to keep a constant pace.

The strip or line search is effective when searching a large exterior area. Examples include large open parking lots and yards where the area can be divided into strips. In a strip search, a single searcher begins on an outer strip and moves down the line. Once at the end of the line, the searcher reverses direction and searches the adjacent line until the whole scene has been searched. Using the same “strip” technique, a line search is a variation of the strip search using multiple searchers. The area is again divided into strips; however, a line of searchers moves over the area simultaneously, covering the entire area at once.

The grid search is another effective search technique that is a variation of the line search. Instead of limiting the search to strips orientated in a single direction, the grid search allows searchers to conduct the search again using strips at a right angle to the original lines. In effect, the search covers all four compass directions, thus allowing a second look for the searcher, ensuring a more effective search.

The zone search is used in two variations. The first variation deals with very small, confined spaces that are not easily searched by any other method, such as a vehicle. A vehicle can be easily divided into zones, permitting the searcher to look at each defined area before moving forward. The second variation involves large scenes that need to be broken down, or subdivided, into smaller areas or zones to be searched effectively, allowing searchers to break down and prioritize specific areas. Breaking down larger areas permits investigators to incorporate a line/strip, grid, or spiral/circle search in each designated zone, allowing for maximum search effort.

When searching for evidentiary items, a number of methods may be used to mark evidentiary items found. Flags or evidence placards affixed with numbers or letters are the most commonly encountered at a scene.

Materials

- Writing utensil

Procedure

1. Examine the characteristics of the crime scene to determine which search method to employ.
2. In the Data Worksheet, describe the scene characteristics that support the chosen search method.
3. Upon discovering evidentiary items, signify them with a placard or flag.
4. Determine an alternative search method should your first choice not be available. Defend your choice of the chosen alternative method.
5. Complete the Data Worksheet.
6. Complete the Post Lab Questions.

Data Worksheet

	Search Method	Characteristics of Scene
Primary search method		
Alternative search method		
Defend the choice of the alternative search method.		

	Search Method	Characteristics of Scene
Primary search method		
Alternative search method		
Defend the choice of the alternative search method.		

Post Lab Questions

1. When is a spiral/circle search used?
2. How many evidentiary items were located at the scene? Describe each.
3. Describe the similarities and differences between the strip and line searches?
4. Describe the two variations of a zone search. Give an example of each.
5. Name and describe the two team approaches.

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Chapter 6

Crime Scene Photography

Key Terms

Overall photographs
Midrange photographs
Evidence close-up photographs
Wide-angle lens
Roadmapping
Scale
Photo placard
Photography log
Fragile evidence
Shutter speed
Focal length
Tripod
Fill-flash
Overexposure
Oblique lighting
Diffuser
Bounce lighting
f/stop
Depth of field
Single-lens-reflex (SLR) camera
Painting with light
Bulb setting

Learning Outcomes

- Understand the modes associated with a camera: program, aperture priority, shutter priority, and manual mode.
- Recognize the importance of depth of field.
- Understand the importance of range photographs for comprehensive scene photography.

6.1 Photography in Manual Mode

Objectives

- Describe the three elements that determine a proper photographic exposure in the manual mode.

- Understand the exposure-level scale as a function of proper image capture in the manual mode.
- Practice image capture in manual mode.

Concept Overview

For the documentation of crime scenes, a digital single-lens-reflex (SLR) camera is the appropriate type to use versus a digital point-and-shoot. An SLR camera contains mirrors and prisms that allow the photographer to see the image in the viewfinder as the lens captures the image. The lens itself is removable from the body of the camera, which makes the digital SLR camera very versatile. For example, an investigator may require the use of lenses with varying focal lengths or, when focused on infinity, the distance between the film plane and the optical center of the lens. For a 35 mm digital SLR camera, a normal lens is 50 mm, a wide-angle lens is less than 50 mm, a telephoto lens is greater than 50 mm, and a macro lens captures subjects 1:1 or life-size. Furthermore, this type of camera has the ability to capture images in several different modes: program, aperture priority, shutter priority, and manual mode. The multiple modes of the camera allow the photographer to capture images based on the characteristics of the subject matter. Moreover, a photographer is capable of maximizing the depth of field of evidentiary items with a digital SLR camera. Depth of field is the zone of focus, in a variable range, in front of and to the rear of the subject matter. The vast majority of the time, the goal of the crime scene photographer is to maximize the depth of field when capturing images. In contrast, digital point-and-shoot cameras are not capable of the versatility required to accurately and properly document crime scenes.

To achieve a proper photographic exposure, three camera elements are manipulated: f/stop, shutter speed, and film speed (sensor sensitivity). The film used in film cameras has various speeds expressed as ISO (International Organization for Standardization) numbers. Film speed refers to the film's sensitivity to light. Common film speeds are ISO 50, ISO 100, ISO 200, ISO 400, ISO 800, and ISO 1600. The lower the ISO number, the less sensitive the film is to light, meaning less light is needed to capture an image.

Digital cameras do not use film. Instead, they contain digital sensors that can be adjusted by the user. The ISO numbers have been maintained within the digital camera and refer to light sensitivity for the digital sensors. As a rule of thumb, cameras should be set to ISO 400 when indoors and ISO 100 when outdoors on a bright, sunny day.

f/stops or F-numbers (also referred to as aperture) relate to the size of the opening of the lens when capturing an image. The f/stop is directly related to the amount of light that is allowed to enter into the lens during capture. The lower the f/stop number, the greater the size of the lens opening, permitting more light to enter the lens. The larger the f/stop number, the smaller the size of the lens opening, allowing less light to enter the lens. This may, at first, seem counterintuitive until one understands that the f/stop is *a fraction of the focal length of the lens being used*. Thus, regardless of the lens used, 1/22 of a number is always smaller than 1/8 of a number (Figure 6.1).

When first learning to manipulate f/stops, captured images may be overexposed, or contain more light than is normal and desired. However, images may also be underexposed, or contain less light than is normal or desired.

Shutter speed relates to the amount of time the lens is allowed to remain open during the capture of an image and is usually expressed in fractions of a second. This camera variable affects motion control, meaning that when the

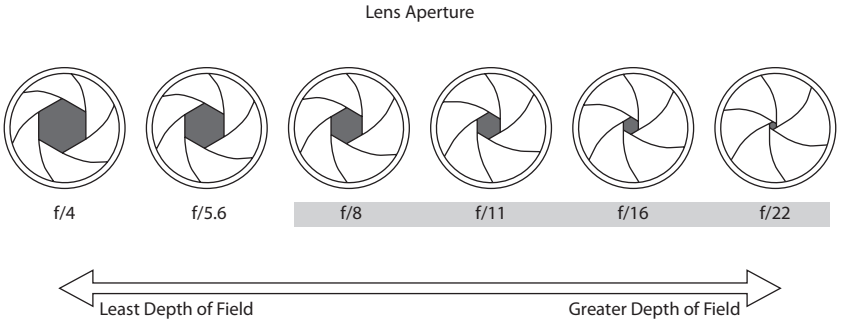

Figure 6.1
Lens aperture.

proper shutter speed is set, based on the characteristics of the subject matter, the subject will appear stationary, free of motion and blur. Shutter speed compensates for the motion of the camera as well as the motion of the photographer. As a rule of thumb, setting a camera's shutter speed to 1/60 of a second will prevent image blur due to camera movement, also known as camera shake. If shutter speeds less than 1/60 of a second are used, a tripod will be necessary. A tripod is a piece of stabilization equipment or platform on which a camera is attached. When taking photographs with a tripod, it is important to prevent the introduction of movement. Thus, a shutter-release cable or the camera's internal timer is used for image capture rather than physically touching the camera. Shutter speed is a powerful photographic tool, as it can freeze the motion of a variety of activities using high shutter speeds, such as walking, talking, jogging, slow-moving vehicles, and fast-moving vehicles. In contrast, the bulb (B) setting allows the photographer to keep the lens open for any length of time required, and may vary from 30 seconds to 3 minutes to 3 hours. It is in the bulb setting that a lighting technique known as *painting with light* is conducted. Through this technique, a large, dimly lit area may be photographed by adding light from a camera flash or flashlight. When first learning to manipulate shutter speeds, captured images may be overexposed or underexposed, but practice will improve the ability to use this variable.

The investigator's goal is to learn how to properly manipulate the f/stop and shutter speed variables for proper image capture. When this is accomplished, both may be manipulated to obtain optimal images in the camera's manual mode. With so many potential combinations between f/stop, shutter speed, and ISO, it may be difficult to choose a starting point. Here are some general guidelines:

1. When indoors, set the camera to ISO 400, and when outdoors on a bright, sunny day, set the camera to ISO 100.
2. Setting the shutter speed to 1/60 will allow the camera to be handheld and will not require stabilization by a tripod.

With the ISO and shutter speed tentatively selected, this leaves the f/stop. f/stop is one of the variables that directly affects the depth of field in the captured image. Recall that in crime scene photography, with very few exceptions, depth of field (DOF) should be maximized. This is the purpose for manipulating the f/stop instead of using the program (automatic) mode of the camera. In program mode, the camera makes the setting decisions, and the f/stop that results is always the lowest f/stop number possible. These low f/stop numbers result in shallow DOF, the opposite of the DOF desired for crime scene photographs. Here is a guideline for determining f/stops:

3. To maximize DOF, set the camera to one of the following: f/8, f/11, f/16, f/22.

An exception to guideline 3 is the desire to capture an object and obscure (blur) the background. To achieve this type of image, the f/stop would need to be set to the lowest f/stop possible. Occasions when an investigator/technician may wish to obscure the background is when the evidentiary item is the only focus of the captured image, such as a fired cartridge case or broken piece of glass. To prevent the viewer from being distracted by the background upon which the evidence is lying, or to prevent the item from being lost among the background, the f/stop may be set very low so that only the desired object is in focus while everything else within the camera's frame is blurred.

Following guidelines 1–3, a starting point for a proper exposure has been set. However, this does not guarantee a proper exposure. The photographer uses the exposure-level scale visible in the camera viewfinder (and on the LCD screen of some cameras) to determine whether continued manipulation of the f/stop or shutter speed is necessary (Figure 6.2).

When the exposure-level mark is in the center of the scale as depicted in the figure, the camera is indicating a properly metered exposure. Moving the mark to the left or right of center will either increase or decrease the brightness

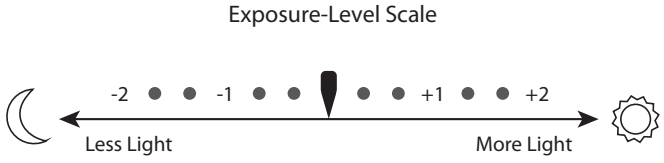

Figure 6.2
Exposure-level scale.

of the captured image. The best practice when taking important photographs is to take at least three: one marked in the center of the scale, one marked adding a stop of light (+1), and one marked removing a stop of light (–1). This process of taking multiple photographs of the same subject, with different light values, is called *bracketing.* Bracketing is important because a camera is a fallible mechanical device. Photographers will find that, at times, a properly metered exposure, as indicated by the camera's exposure-level scale, may still be either overexposed or underexposed.

An important piece of photographic equipment is an off-camera flash. Digital SLR cameras have built-in pop-up flashes, but these are limiting due to their light output. Off-camera flashes have much more power than pop-up flashes and are much more versatile, as they can be positioned in a variety of angles. When they are angled so that the flash bounces off of ceilings or walls, this is known as the bounce lighting technique. This technique, through bouncing light off of nearby surfaces, will allow softer light to fall on the subject rather than using harsh, direct lighting. A diffuser can also be used to soften the lighting on a subject. A diffuser is a piece of equipment, usually a piece of plastic that covers the flash, that diffuses the harshness of the emitted light. The use of a remote flash cord also enhances the versatility of the off-camera flash. This cord connects to the camera's hot shoe and to the off-camera flash. In this configuration, the photographer holds the camera in one hand while holding the flash in the other. The flash is then able to be directed to any location where light is needed. For example, oblique lighting or side lighting, which is accomplished by holding the flash at 45 degrees or less, is a photographic lighting technique that would not be possible if the flash could not be manipulated away from the camera body. Oblique lighting is very useful when photographing impression evidence such as footwear, toolmarks, and bite marks. Another valuable flash technique is known as fill-flash. This technique is employed when there are shadowed areas in the composition. The flash is positioned so that the emitted light falls onto the shadowed area to illuminate it.

Materials

- Digital camera
- Writing utensil

Procedure: f/stop

1. Set the digital camera to the manual setting; all photographs will be taken in this setting.
2. Set the camera to ISO 100 if photographing outdoors; set the camera to ISO 400 if photographing indoors.
3. Set the camera's shutter speed to at least 1/30 or 1/60 to allow hand-holding of the camera, without camera shake or use of a tripod.
4. Set the camera's f/stop to its lowest number (f/4, f/5.6, f/8) and take a photograph of a subject. Record the settings used to capture the image in the provided photography log.
5. Maintain all camera settings except the f/stop; change it to the highest number (f/16, f/22, f/32) and take a photograph of the same subject used in step 4. Record the camera settings in the photography log.
6. Compare the two images to visualize the function of f/stops.
7. Maintain the camera settings and manipulate only the f/stop. Photograph the same subject using the full range of f/stops available for your camera. Record the settings of each photograph. Review your photographs.
8. Complete the Post Lab Questions.

Photography Log					
Activity:		Photographer:			
Date:		Location:			
Camera used:				Time start:	Time end:
Photo No.	ISO	Aperture	Shutter Speed	Lens	Subject Description

Procedure: Shutter Speed

1. Set the digital camera to the manual setting; all photographs will be taken in this setting.
2. Set the camera to ISO 100 if photographing outdoors; set the camera to ISO 400 if photographing indoors.
3. Set the camera's f/stop to its lowest number (f/4, f/5.6, f/8).
4. Set the camera's shutter speed to at least 1/30 or 1/60 to allow hand-holding of the camera, without camera shake or use of a tripod, and take a photograph of a subject in motion. Record the settings used to capture the image in the provided photography log.
5. Maintain all camera settings except the shutter speed; change it to the camera's highest number (1/500, 1/1000, 1/2000) and take a photograph of the same subject used in step 4. Record the camera settings in the photography log.
6. Compare the two images to visualize the function of shutter speeds.
7. Maintain the camera settings and manipulate only the shutter speed. Photograph the same subject or similar subject using the following range of shutter speeds: 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/500, 1/1000. Record the settings of each photograph. Review your photographs.

Photography Log					
Activity:		Photographer:			
Date:		Location:			
Camera used:				Time start:	Time end:
Photo No.	ISO	Aperture	Shutter Speed	Lens	Subject Description

Procedure: Manual Mode

1. Set the digital camera to the manual setting; all photographs will be taken in this setting.
2. Set the camera to ISO 100 if photographing outdoors; set the camera to ISO 400 if photographing indoors.
3. Set the camera's shutter speed to at least 1/30 or 1/60.
4. To maximize depth of field, choose one of the following f/stops and set the camera: f/8, f/11, f/16, f/22.
5. Refer to the camera's exposure-level scale visible through the viewfinder and/or the LCD screen. The camera will indicate a properly metered exposure when the level mark is in the center of the scale.
6. Photograph a subject when a properly exposed image is indicated by the exposure-level scale. Record the camera settings in the photography log. Then, manipulate either the shutter speed or f/stop to add one stop of light (level mark on +1) or lose one stop of light (level mark on –1). Record these settings in the photography log.
7. Take photographs of multiple subjects using this method of capturing three photographs of each subject with the level mark at 0, +1, and –1. Record all camera settings for each subject in the photography log.
8. Review your photographs to identify deficiencies and take corrective action.

Photography Log					
Activity:		Photographer:			
Date:		Location:			
Camera used:				Time start:	Time end:
Photo No.	ISO	Aperture	Shutter Speed	Lens	Subject Description

Post Lab Questions

1. What is the appropriate type of camera to use when documenting crime scenes?
2. What is depth of field?
3. When shooting an indoor scene, what ISO should be used?
4. What do f/stop numbers refer to?
5. Why is shutter speed important?
6. How can bracketing be useful?
7. Why is oblique lighting useful?

6.2 Capturing Range Photographs

Objective

- Describe the three basic range photographs.
- Explain the purpose of the Crime Scene Photo Log.
- Practice capturing range photographs, to include overall, midrange, and close-up photographs.

Concept Overview

Photography is an essential step in the documentation process. Graphic information is easy to comprehend and shows the real-life context of a crime scene. When used in combination, photographs and verbal testimony are powerful tools used to paint a picture for jurors.

Three basic range photographs are taken to ensure that the entire scene is captured; these consist of overall, midrange, and close-up photographs. Overall photographs depict the general condition and layout of the scene. They should show how the scene is oriented and where major landmarks exist, such as street signs outside or furniture in a room. Midrange photographs are important when photographing a scene. Smaller items are often left behind as evidence and are so small that they are not visible in overall photographs. Midrange photographs are used to establish the location of an item within the scene by making sure that the object is in the frame in conjunction with another scene landmark. This helps to orient it with other items that are present. Close-ups of specific items are taken at the closest range possible. Technicians are taught to fill the frame of the camera with the item. The purpose of close-up photographs is to obtain as much detail of the item as possible. These photographs should be taken with and without a scale. Scales included in the photos aid in making 1:1, or life-size, recreations of the item. While photographs are typically taken from the general to the specific, from overalls to close-ups, it may be necessary in some cases to alter this protocol. When fragile evidence, such as hairs and fibers, is located at a scene, it is important to photograph and collect them as soon as possible. Fragile evidence may be lost or damaged while taking other photographs, which ultimately hurts the investigation.

Photo placards can be used to show the chronological order in which evidentiary items were found and help in evidence identification in overall photographs. The placards may be preprinted numbers or letters, plastic tents that can be ordered from a number of distributors, or simply folded index cards with numerical or alphabetical notations on them.

Roadmapping is a technique used to photograph bloodstains. It incorporates the three basic photography techniques (discussed above) in conjunction with a variety of placards and scales in order to accurately reflect the orientation and position of the stains.

The crime scene photo log is an important tool in crime scene photography. The photo log keeps track of each photograph taken and describes what the picture was intended to depict. Photo logs vary in design from simple to very detailed. To be beneficial to the investigation, the log should contain, at the very minimum, the subject matter and exposure number. Additional data, such as distance, time, aperture, shutter speed, and any other remarks, may also be beneficial to the investigation.

Materials

- Digital camera
- Writing utensil

Procedure

1. Set the digital camera to the manual setting, if applicable.
2. If applicable, do the following:
   - Set the camera to ISO 100 if photographing outdoors; set the camera to ISO 400 if photographing indoors.
   - Set the camera's shutter speed to at least 1/30 or 1/60 (to prevent camera shake).
   - To maximize depth of field, choose one of the following f/stops and set the camera: f/8, f/11, f/16, f/22.
3. Document the evidentiary items by capturing range photographs, to include overall, midrange, and close-up photographs. Use placards/identifiers and a scale when appropriate.
4. Record all captured images, including the settings used for capture, in the photography log.
5. Complete the Post Lab Questions.

Photography Log					
Activity:		Photographer:			
Date:		Location:			
Camera used:				Time start:	Time end:
Photo No.	ISO	Aperture	Shutter Speed	Lens	Subject Description

Post Lab Questions

Picture Number	Strength	Weakness

1. Evaluate 12 of the photographs taken in the exercise above. Describe the strengths and weaknesses of each photograph.
2. Describe the three basic photographs.
3. What is roadmapping?
4. What is the purpose of a photo log?
5. Why might photo placards be especially helpful in regard to jury members?
6. Why is it beneficial to have photographs with and without a scale?

6.3 Documenting a Crime Scene

Objective

- Students will properly document a crime scene utilizing proper photographic methodology.

Concept Overview

The mock crime scene is the accumulative evaluation of the techniques one has learned in the previous exercises. It is important to remember the following items when photographing the scene:

- Capture the full range of photographs, including overall, midrange, and close-up. Be sure to include a scale when necessary.
- Use proper alignment of the camera lens with the subject. Remember that it is important to be perpendicular to the subject.
- Use evidence placards to identify evidence.
- Use a proper scale.
- Maximize depth of field.

Materials

- Digital camera
- Writing utensil

Procedure

1. If applicable, do the following:
   - Set the digital camera to the manual setting.
   - Set the camera to ISO 100 if photographing outdoors; set the camera to ISO 400 if photographing indoors.
   - Set the camera's shutter speed to at least 1/30 or 1/60 (to prevent camera shake).
   - To maximize depth of field, choose one of the following f/stops and set the camera: f/8, f/11, f/16, f/22.
2. Document the crime scene using proper photographic methodology to include:
   - Capturing range photographs (overall, midrange, close-up)
   - Proper alignment of the camera lens with the subject (perpendicular)
   - Proper use of evidence placards/identifiers
   - Proper use of a scale
   - Maximizing depth of field
3. Record all captured images, including the settings used for capture, in the photography log.
4. Complete the Post Lab Questions.

Photography Log					
Activity:		Photographer:			
Date:		Location:			
Camera used:				Time start:	Time end:
Photo No.	ISO	Aperture	Shutter Speed	Lens	Subject Description

Photography Log					
Activity:		Photographer:			
Date:		Location:			
Camera used:				Time start:	Time end:
Photo No.	ISO	Aperture	Shutter Speed	Lens	Subject Description

Post Lab Questions

1. What are the four key elements in crime scene documentation?
2. Why is it important to document a crime scene?
3. What is the purpose of bracketing photographs?
4. How can shutter speed affect the resulting photograph?
5. How can one prevent overexposure when using a fill-flash?

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Chapter 7

Crime Scene Sketching and Mapping

Key Terms

Heading
Diagram area
Legend
Title block
Scale of reference
Orientation
Cross-projection sketch
Elevation sketch
Three-dimensional sketch
Rectangular coordinates
Triangulation
Baseline coordinates
Polar coordinates
English measurement system
Metric measurement system

Learning Outcomes

1. Understand the purpose of a crime scene sketch.
2. Identify the five essential elements of a sketch.
3. Review the three viewpoints used in crime scene sketching.
4. Identify the four basic methods of mapping a crime scene sketch.

7.1 Measuring with English and Metric Rulers

Objective

- Explain the difference between the English and metric systems of measurement.
- Practice measuring with English and metric rulers.

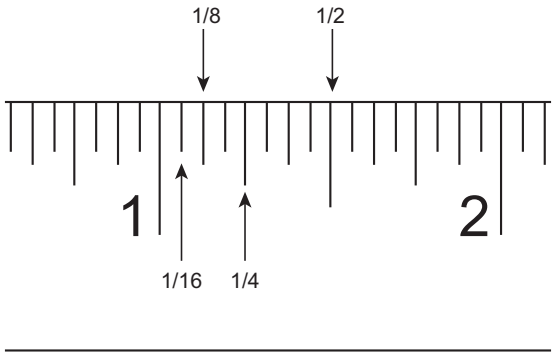

Figure 7.1
One-inch ruler broken down in 1/16 increments.

Concept Overview

The ability to accurately collect measurements is a crucial skill in crime scene investigation. Collecting incorrect or inaccurate measurements can affect the evidentiary value of scene diagrams and result in erroneous conclusions from shooting incident reconstructions, crime scene reconstructions, and bloodstain pattern analysis. Investigators must be able to use English and metric rulers, which are based on two very different measurement systems.

The most commonly used measurement system in the United States is the English system, which uses feet and inches for length units. One foot is composed of 12 inches, and each inch is broken down into fractions. Reading fractions on a ruler can result in erroneous or inaccurate measurements. Figure 7.1 depicts the fractions on a 1-inch ruler that is broken down into 1/16 increments.

The graduations, or lines/marks, on the ruler vary in length. The longest is in the center or at the halfway point of the 1-inch span. This is a 1/2-inch segment. The next longest graduation represents a 1/4-inch segment. There are four 1/4-inch sections per inch since 1/4 + 1/4 + 1/4 + 1/4 = 1 (inch). The next longest graduation signifies a 1/8-inch segment. There are eight 1/8-inch sections per inch since the sum of those sections equals 1 inch. The shortest graduation on the ruler represents a 1/16-inch segment. There are sixteen 1/16-inch graduations since 16/16 = 1 (inch). Familiarization with fractions is important when reading a ruler, because the relationships between the fractions will be clear. For example, examine the equivalent fractions below.

2/4 = 1/2
2/8 = 1/4
4/8 = 1/2
6/8 = 3/4
2/16 = 1/8
4/16 = 1/4
6/16 = 3/8
8/16 = 1/2
10/16 = 5/8
12/16 = 3/4
14/16 = 7/8

The fraction on the left was simplified by dividing the numerator (top number) and denominator (bottom number) by the highest number that can divide evenly into both of them. If lacking experience in reading rulers, count each graduation on the ruler to derive the measurement. Then, if necessary, simplify the resulting fraction. Soon, experience will lead to quicker, more accurate measurements.

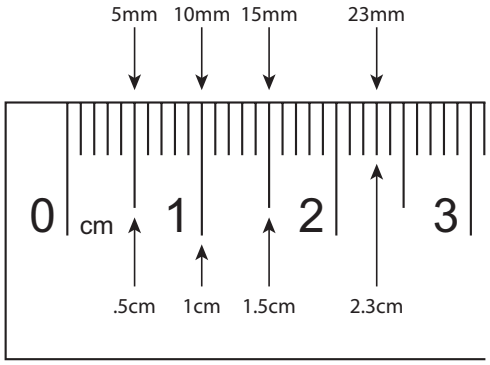

Figure 7.2
Metric ruler in centimeters.

When compared with the English system, the metric system is much simpler, because fractions are not used. Rather, in this system, to move between units of length, one must simply multiply or divide by 10. Metric units of length are the meter, centimeter (cm), and millimeter (mm). On a ruler, the units are typically centimeters and millimeters. One centimeter is composed of 10 mm (Figure 7.2).

Thus, 4 cm is the equivalent of 40 mm. Sixty millimeters is 6 cm, while 6 mm is 0.6 cm. This is considered a decimal system, because movement between the unit lengths is a function of base-10 and results by moving the decimal point. For any given number, the decimal point is moved to the right for larger units of length and moved to the left for smaller units of length.

It is important to be familiar with this measurement system because some types of evidence are, as a rule, to be measured in metric. For example, bloodstains and bullet strikes are measured in millimeters.

Materials

- Writing utensil

Procedure

1. Use the rulers provided in this manual to measure the practice figures with both the English and metric systems of measurement.
2. On the item measured, make reference marks to indicate where the measurement started and finished.
3. Record your measurements in the Data Worksheet.
4. The instructor will confirm your measurements.
5. Complete the Post Lab Questions.

Practice Figures

_____ cm
_____ mm
_____ inches

Figure 7.3
Knife.

_____ cm
_____ mm
_____ inches

Figure 7.4
Nail.

_____ cm
_____ mm
_____ inches

Figure 7.5
Fired cartridge case.

_____ cm
_____ mm
_____ inches

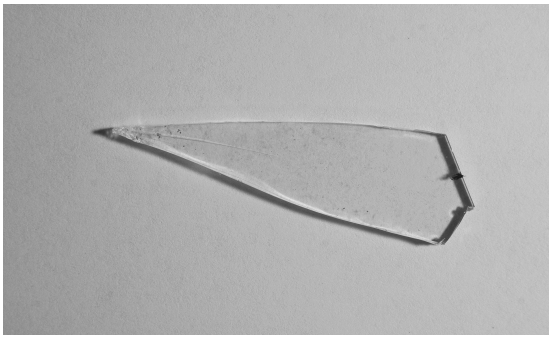

Figure 7.6
Broken piece of glass.

_____ cm
_____ mm
_____ inches

Figure 7.7
Fired bullet.

_____ cm
_____ mm
_____ inches

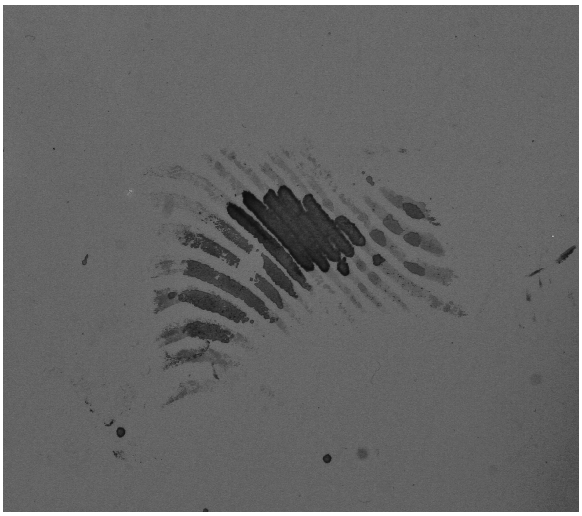

Figure 7.8
Shoeprint.

Data Worksheet

Object	English Measurement (inches)	Metric Measurement (cm and mm)
Knife		
Nail		
Fired cartridge case		
Broken piece of glass		
Bullet		
Scuff mark		

Post Lab Questions

1. What is the base unit of the metric system?
2. How many centimeters are in 125¾ inches?
3. Covert each of the measurements:

4 inches	cm
35 inches	mm
78½ inches	cm
520 cm	mm
400 mm	inches

4. Find the lowest common denominator.

16/48	
3/9	
48/120	
14/16	
20/32	

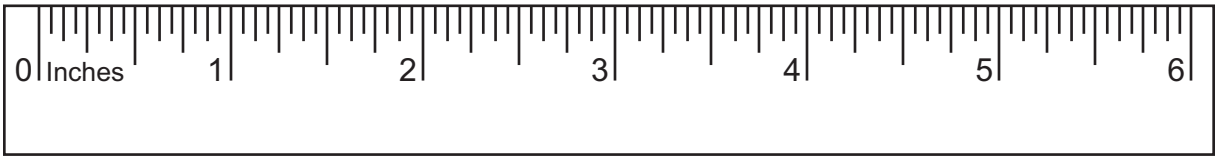

Figure 7.9
English ruler. (See back of book for a version of this ruler that can be cut out and used.)

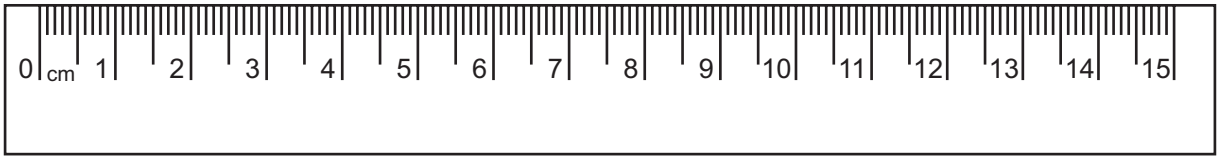

Figure 7.10
Metric ruler. (See back of book for a version of this ruler that can be cut out and used.)

7.2 Creating an Indoor Sketch

Objective

- Students will use the appropriate mapping method to create a sketch of an indoor area.

Concept Overview

Together, crime scene sketching and mapping create a picture of the crime scene. A sketch is the actual drawing itself, while crime scene mapping is the technique chosen to measure and document the elements within the scene. All sketches should contain five essential elements:

- Heading: Information that indicates the purpose of the sketch.
- Diagram area: The drawing itself.
- Legend: Indication of what various labels (usually numbers or letters) represent.
- Title block: Area that provides important information relevant to the location of the scene and its creator.
- Scale and direction notation: Scale notes the scale of reference that was used in the sketch. If no scale was used, "not drawn to scale" should be noted on the sketch. Direction notation suggests the compass direction.

A rough sketch begins the process. Rough sketches contain *all* the measurements within the scene and are usually done on standard white paper or graph paper and drawn in pencil. A title block, legend, and scale/direction should be noted on the rough sketch as well. Final sketches occur in a variety of formats. Hand-drawn sketches are completed in pen on white paper or graph paper, while computer-generated final sketches may appear in a range of formats.

Variations on the view or perspective of the sketch can provide the creator with the option to use the one that is most beneficial for viewing the scene. Three common perspective variations are cross-projection or exploded, elevation, and three-dimensional sketches. The standard cross-projection sketch provides a bird's-eye view of the crime scene. The exploded cross-projection sketch provides a bird's-eye view of the scene while simultaneously laying down the walls. This would allow any evidentiary items, such as bullet strikes or blood evidence located on the walls or other vertical surfaces, to be oriented, making their interrelationship with other items at the scene plain and understandable. The elevation sketch is a drawing depicting a side view of some portion of the scene, typically an interior wall or similar vertical structure. The three-dimensional sketch offers the ability to present the crime scene in a realistic perspective, or as the human eye sees it. These sketches are generally produced using software that allows the jury to get a real feel for the scene.

Mapping the scene is the act of taking measurements of all items within the scene and documenting them, which is also known as plotting or fixing evidence. There are four basic techniques for mapping a scene:

1. Rectangular coordinates: This method is best suited for crime scenes with clear and specific boundaries, such as walls. It is a good method to use for interior crime scenes and can be a fast and effective manner of measuring. The rectangular coordinates mapping technique only requires two measurements from any item within the scene. The procedure for plotting evidence with rectangular coordinates is as follows:
   a. Choose two fixed reference points (typically walls). All measurements will be taken from these points and may be thought of as x and y coordinates.
   b. Each item of evidence is plotted separately. Choose a location on the fixed point (wall) that is near the evidentiary item. Keep the end of the tape (metal hook) in contact with the fixed point (wall) while the tape is pulled out until it reaches the item. Ensure that the tape measure is perpendicular or 90 degrees from the fixed point to the item. Record the measurement.
   c. From the second fixed point (wall), repeat this procedure. (Through this mapping method, two perpendicular lines are created and used to plot items.)
   d. Whether or not to include these measurements on a finished sketch depends on the complexity of the scene and the number of items or objects mapped.

2. Triangulation: This method is very effective in "fixing" items in the crime scene. The number of measurements taken is determined by whether the item being measured is regular (definite/defined sides or edges) or irregular (amorphous). Items that are regular will not change shape with movement and require a minimum of four measurements. For example, the furniture in a room and a gun are regularly shaped items. Irregularly shaped items are asymmetric with no definable shape and would change shape with movement. Irregularly shaped items require two measurements from two fixed objects in the room to the center mass of the object being measured. For example, an article of clothing changes shape when moved and is therefore irregular. Triangulation is a useful tool when the sketch creator wants to fix items within the crime scene. However, the method can be very time-consuming and typically requires more than one person to obtain the measurements. The procedure for plotting evidence with rectangular coordinates is as follows:
   a. Locate two fixed (permanent) objects (door frames, room corners).
   b. Keep the end of the tape (metal hook) in contact with the fixed point while the tape is pulled out until it reaches the item to be plotted. For regular objects, the measurement will be taken at a corner or edge. For irregular objects, the measurement will be taken at center mass. Record the measurement.
   c. From the second fixed/permanent point, repeat this procedure.
   d. Record the distance between the two fixed points. (This is the base of the triangle. With all measurements recorded, a triangle has been created.)
   e. A separate triangle is formed for each item or object mapped.
   f. Whether or not to include these measurements on a finished sketch depends on the complexity of the scene and the number of items or objects mapped.
3. Baseline coordinates: This method is best utilized for outdoor scenes without evident landmarks, although it can also be used indoors. Typically, a general search of an area has been conducted, and items of possible evidentiary value have been located. Such discovery assists in productive, efficient placement of the baseline. First, a datum point is established and the baseline is extended in one cardinal direction (north, south, east, or west). A soft (vinyl) measuring tape is the best tool to use as the baseline. The procedure for plotting evidence with baseline coordinates is as follows:
   a. Each item of evidence is plotted separately. When an item is located *along* the baseline, a measurement along the soft tape is recorded. (This can be considered the *x* coordinate.)
   b. A second measuring device is used to determine the object's distance *from* the baseline (soft tape). (This can be considered the *y* coordinate.)
   c. The object's direction from the baseline should also be recorded. (For example, if the baseline is oriented in a west to east direction, the plotted item will be either north or south of the baseline.)
   d. Repeat this procedure for each item or object mapped.
4. Polar coordinates: This method is used in mapping exterior scenes where evidence is scattered over a large, relatively open area. It is not effective in heavily wooded areas or where large obstacles may block the line of sight. Polar coordinates are based on surveying techniques and are generally conducted by personnel who are trained in the technique.

Sketching is an important form of documentation. Sketches supplement photographs and notes taken at the crime scene. Together, they provide a comprehensive view of the scene for a jury and allow the jury to view the interrelationships of evidence and items located within the crime scene.

Materials

- Writing utensil

Procedure

1. Create a rough sketch of an indoor area using either a projection or cross-projection view, using the blank sketch canvas provided. Either the mapping method will be assigned by the instructor or you will choose to use *rectangular coordinates* or *triangulation*. Use the Mapping Measurement Record to assist you with measurement data collection.
2. Submit your rough sketch to the instructor for evaluation.
3. After the rough sketch is approved, create a finished sketch on the sketch canvas (graph paper) provided for submission that includes the necessary elements:
   - Heading
   - Diagram area
   - Legend
   - Title block
   - Scale of reference
   - Direction orientation
4. Submit your finished sketch to the instructor for evaluation.
5. Complete the Post Lab Questions.

Sketch Canvas

Mapping Measurement Record: Rectangular Coordinates			
Sketch artist:		**Date:**	
Location:			
Placard No.	**Object**	***x* Measurement**	***y* Measurement**

Mapping Measurement Record: Triangulation						
Sketch artist		**Date:**				
Location:						
Placard No.	**R or IR**	**Object**	**RP-1**	**RP-2**	**RP-3**	**RP-4**

Sketch Canvas

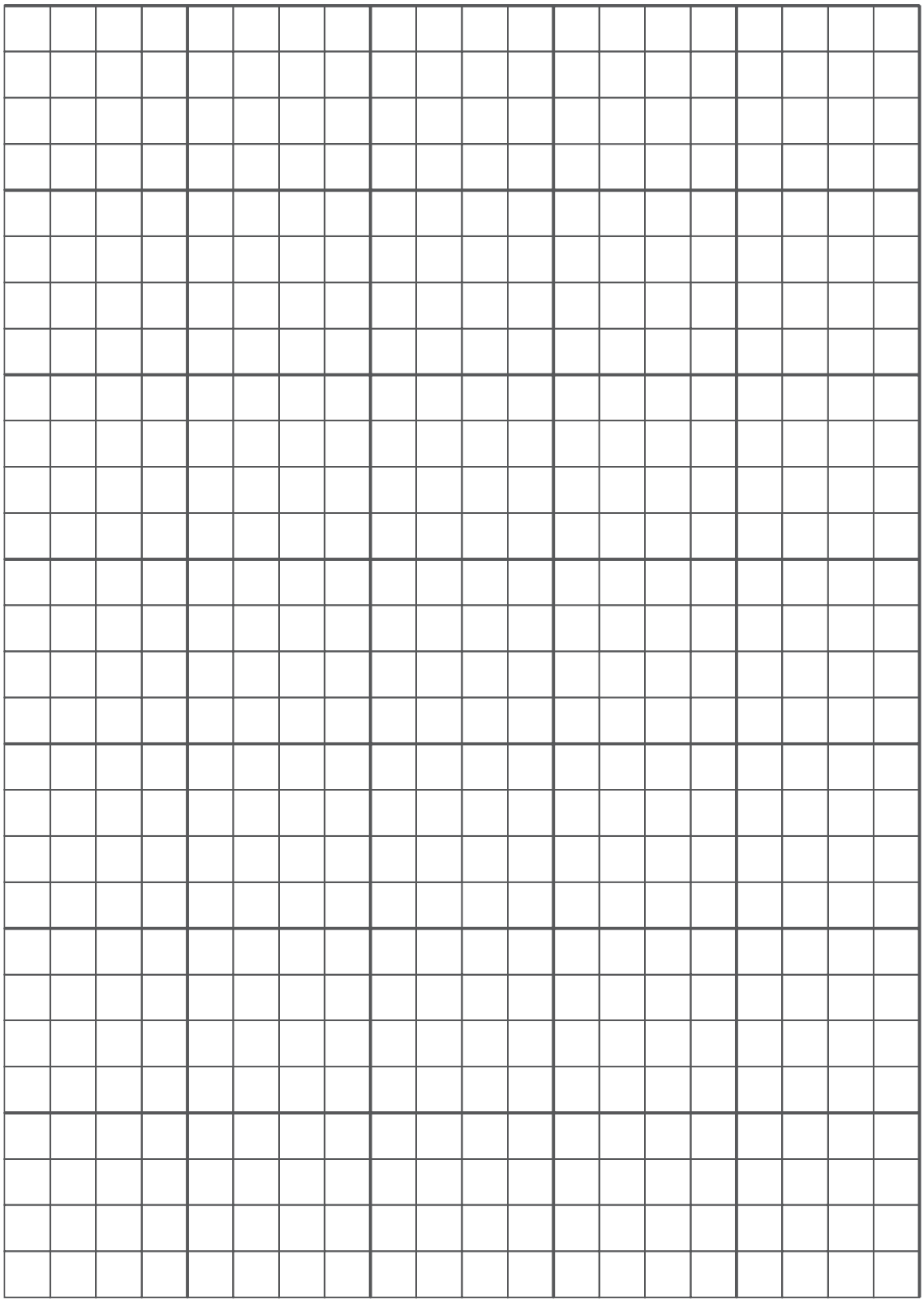

Figure 7.9
Graph paper.

Post Lab Questions

1. What mapping method was used for the scene? Was the mapping method easy to use? Explain?
2. What are the five key elements of a crime scene sketch? Name and describe each?
3. How might a sketch be beneficial in courtroom testimony?
4. When would an elevation sketch be used? Give an example?
5. Define a cross-projection sketch.

7.3 Creating an Outdoor Sketch

Objective

- Students will use the appropriate mapping method to create a sketch of an outdoor area.

Concept Overview

Together, crime scene sketching and mapping create a picture of the crime scene. A sketch is the actual drawing itself, while crime scene mapping is the technique chosen to measure and document the elements within the scene. All sketches should contain five essential elements:

- Heading: Information that indicates the purpose of the sketch.
- Diagram area: The drawing itself.
- Legend: Indication of what various labels (usually numbers or letters) represent.
- Title block: Area that provides important information relevant to the location of the scene and its creator.
- Scale and direction notation: Scale notes the scale of reference that was used in the sketch. If no scale was used, "not drawn to scale" should be noted on the sketch. Direction notation suggests the compass direction.

A rough sketch begins the process. Rough sketches contain *all* the measurements within the scene and are usually done on standard white paper or graph paper and drawn in pencil. A title block, legend, and scale/direction should be noted on the rough sketch as well. Final sketches occur in a variety of formats. Hand-drawn sketches are completed in pen on white paper or graph paper, while computer-generated final sketches may appear in a range of formats.

Variations on the view or perspective of the sketch can provide the creator with the option to use the one that is most beneficial for viewing the scene. Three common perspective variations are cross-projection or exploded, elevation, and three-dimensional sketches. The standard cross-projection sketch provides a bird's-eye view of the crime scene. The exploded cross-projection sketch provides a bird's-eye view of the scene while simultaneously laying down the walls. This would allow any evidentiary items, such as bullet strikes or blood evidence located on the walls or other vertical surfaces, to be oriented, making their interrelationship with other items at the scene plain and understandable. The elevation sketch is a drawing depicting a side view of some portion of the scene, typically an interior wall or similar vertical structure. The three-dimensional sketch offers the ability to present the crime scene in a realistic perspective, or as the human eye sees it. These sketches are generally produced using software that allows the jury to get a real feel for the scene.

Mapping the scene is the act of taking measurements of all items within the scene and documenting them. There are four basic techniques for mapping a scene:

1. Rectangular coordinates: This method is best suited for crime scenes with clear and specific boundaries, such as walls. It is a good method to use for interior crime scenes and can be a fast and effective manner of measuring. The rectangular coordinates mapping technique only requires two measurements from any item within the scene. While the measurements document the location of the item, the item could still be rotated 360 degrees; therefore, it is not fixed within the scene.

2. Triangulation: This method is very effective in "fixing" items in the crime scene. Measurements are taken based on whether the item being measured is regular or irregular. Items that are regular will not change shape with movement and require a minimum of four measurements. For example, the furniture in a room and a gun are regularly shaped items. Irregularly shaped items are asymmetric with no definable shape and would change shape with movement. Irregularly shaped items require two measurements from two fixed objects in the room to the center mass of the object being measured. For example, an article of clothing changes shape when moved and is therefore irregular. Triangulation is a useful tool when the sketch creator wants to fix items within the crime scene. However, the method can be very time-consuming and typically requires more than one person to obtain the measurements.
3. Baseline coordinates: This method is best utilized for outdoor scenes without evident landmarks, although it can also be used indoors. In an exterior scene, a datum point is established and the baseline is extended in one cardinal direction (north, south, east, or west). The best method for creating a baseline is to use measuring tape, but if this is not available, a long piece of string or a line with reference points is suitable.
4. Polar coordinates: This method is used in mapping exterior scenes where evidence is scattered over a large, relatively open area. It is not effective in heavily wooded areas or where large obstacles may block the line of sight. Polar coordinates are based on surveying techniques and are generally conducted by personnel who are trained in the technique.

Sketching is an important form of documentation. Sketches supplement photographs and notes taken at the crime scene. Together, they provide a comprehensive view of the scene for a jury and allow the jury to view the interrelationships of evidence and items located within the crime scene.

Materials

- Writing utensil

Procedure

1. Create a rough sketch of an outdoor area using a projection view, using the blank sketch canvas provided. The mapping method will be *baseline coordinates*. Use the Mapping Measurement Record to assist you with measurement data collection. For the purpose of *baseline coordinate* sketches, the *x* measurement should notate the measurement located along the baseline of the measuring tape. The *y* measurement should notate the distance the object is from the baseline.
2. Submit your rough sketch to the instructor for evaluation.
3. After the rough sketch is approved, create a finished sketch on the sketch canvas (graph paper) provided for submission that includes the necessary elements:
   - Heading
   - Diagram area
   - Legend
   - Title block
   - Scale of reference
   - Direction orientation
4. Submit your finished sketch to the instructor for evaluation.
5. Complete the Post Lab Questions.

Sketch Canvas

Mapping Measurement Record: Baseline Coordinates				
Sketch artist:			**Date:**	
Location:				
Placard No.	**Object**	**Compass Direction from Baseline**	***x* Measurement**	***y* Measurement**

Sketch Canvas

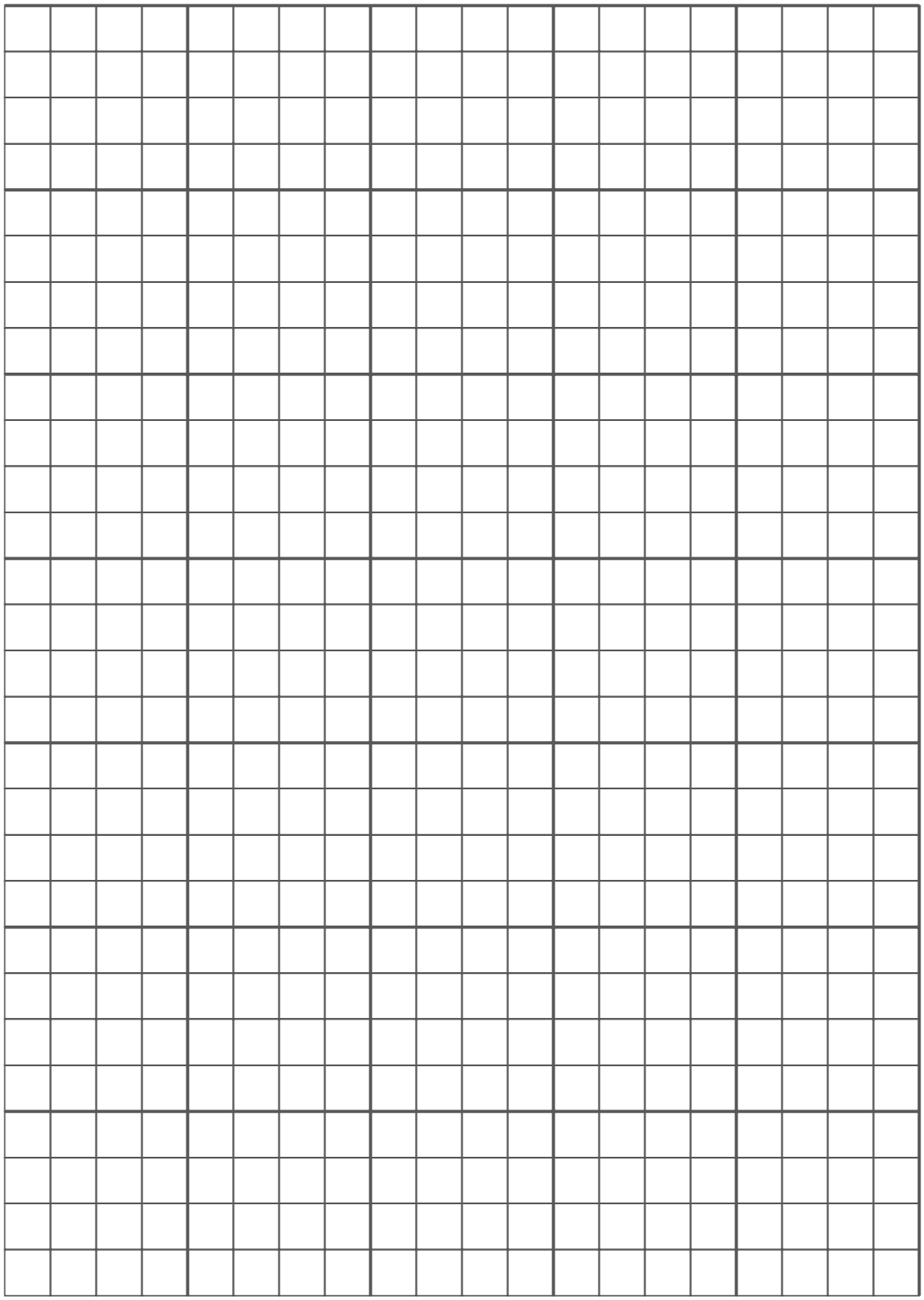

Figure 7.10
Graph paper.

Post Lab Questions

1. Describe the concept of baseline mapping.
2. Why is triangulation considered a more accurate form of measuring?
3. In what type of scene are rectangular coordinate measurements best implemented?
4. Why is accuracy in sketching important?
5. What are some challenges to completing a crime scene sketch outdoors?

7.4 Sketching a Crime Scene

Objective

- Students will use the appropriate mapping method to sketch a crime scene.

Concept Overview

Together, crime scene sketching and mapping create a picture of the crime scene. A sketch is the actual drawing itself, while crime scene mapping is the technique chosen to measure and document the elements within the scene. All sketches should contain five essential elements:

- Heading: Information that indicates the purpose of the sketch.
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2. Triangulation: This method is very effective in "fixing" items in the crime scene. Measurements are taken based on whether the item being measured is regular or irregular. Items that are regular will not change shape with movement and require a minimum of four measurements. For example, the furniture in a room and a gun are regularly shaped items. Irregularly shaped items are asymmetric with no definable shape and would change shape with movement. Irregularly shaped items require two measurements from two fixed objects in the room to the center mass of the object being measured. For example, an article of clothing changes shape when moved and is therefore irregular. Triangulation is a useful tool when the sketch creator wants to fix items within the crime scene. However, the method can be very time-consuming and typically requires more than one person to obtain the measurements.
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4. Polar coordinates: This method is used in mapping exterior scenes where evidence is scattered over a large, relatively open area. It is not effective in heavily wooded areas or where large obstacles may block the line of sight. Polar coordinates are based on surveying techniques and are generally conducted by personnel who are trained in the technique.

Sketching is an important form of documentation. Sketches supplement photographs and notes taken at the crime scene. Together, they provide a comprehensive view of the scene for a jury and allow the jury to view the interrelationships of evidence and items located within the crime scene.

Materials

- Writing utensil

Procedure

1. Create a rough sketch of the scene presented by the instructor. The view of the scene should be through a projection sketch or cross-projection sketch, using the blank sketch canvas provided. The mapping method utilized will be indicated by the instructor, or you will choose the appropriate method based on the scene location: *rectangular coordinates* (indoors), *triangulation* (indoors), or *baseline coordinates* (outdoors). Use the Mapping Measurement Record to assist you with measurement data collection.
2. Submit your rough sketch to the instructor for evaluation.
3. After the rough sketch is approved, create a finished sketch on the sketch canvas (graph paper) provided for submission that includes the necessary elements:
   - Heading
   - Diagram area
   - Legend
   - Title block
   - Scale of reference
   - Direction orientation
4. Submit your finished sketch to the instructor for evaluation.
5. Complete the Post Lab Questions.

Sketch Canvas

Mapping Measurement Record: Rectangular Coordinates			
Sketch artist:		**Date:**	
Location:			
Placard No.	**Object**	***x* Measurement**	***y* Measurement**

Mapping Measurement Record: Triangulation						
Sketch artist:		**Date:**				
Location:						
Placard No.	**R or IR**	**Object**	**RP-1**	**RP-2**	**RP-3**	**RP-4**

Mapping Measurement Record: Baseline Coordinates				
Sketch artist:			**Date:**	
Location:				
Placard No.	**Object**	**Compass Direction from Baseline**	***x* Measurement**	***y* Measurement**

Sketch Canvas

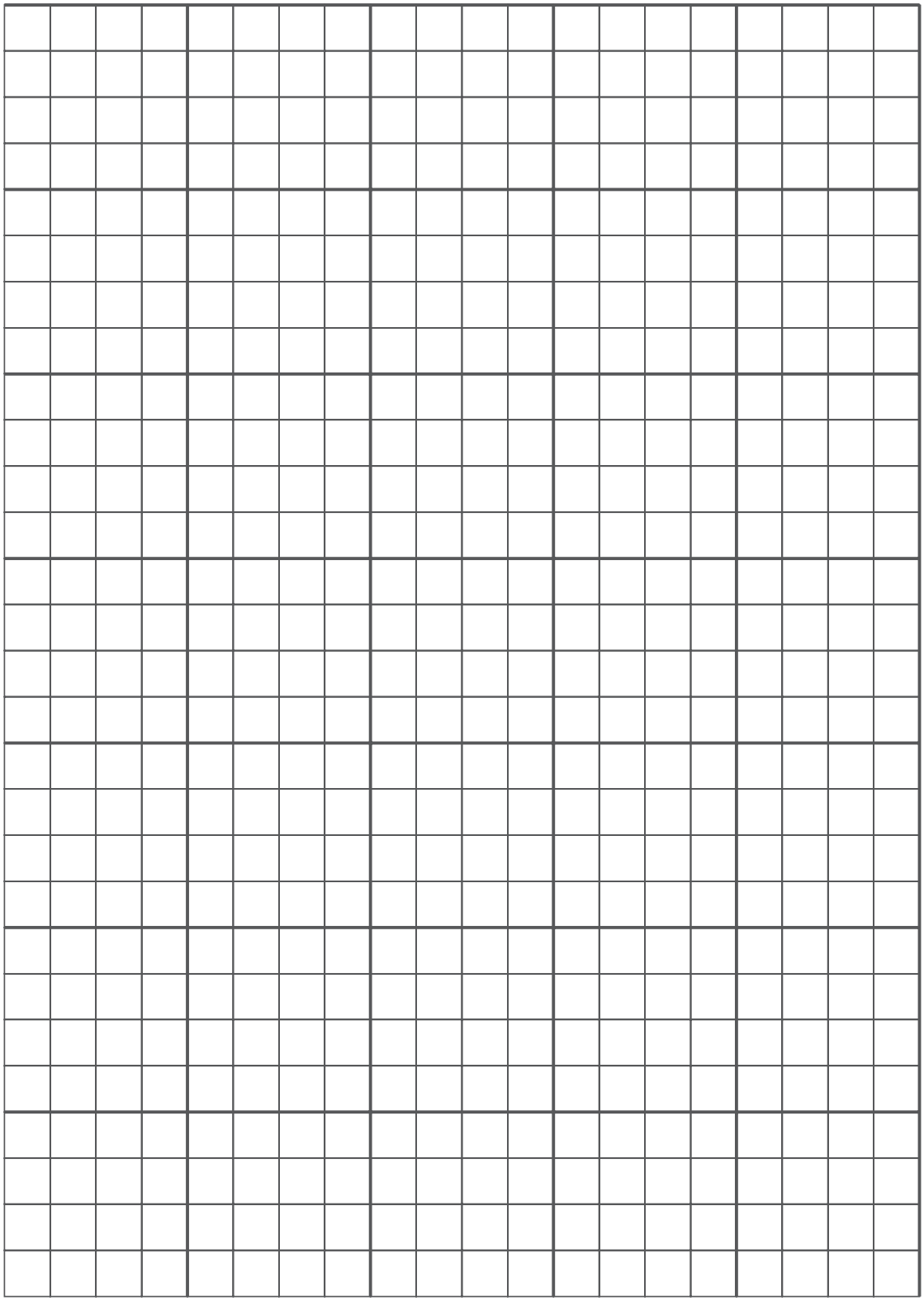

Figure 7.11
Graph paper.

Post Lab Questions

1. Were you systematic and methodical in sketching the scene provided?
2. How might multiple people assisting in the sketching of the scene be beneficial? How might this be problematic?
3. How is the rough sketch different from the finished sketch?
4. Could a baseline sketch be used at an indoor crime scene? Why or why not?
5. What was the easiest form of measurement: inches, centimeters, or millimeters? Explain?

Bibliography

Gardner, Ross M., and Donna R. Krouskup. 2018. *Practical Crime Scene Processing and Investigation*. 3rd ed. Boca Raton, FL: CRC Press.

Taylor & Francis
Taylor & Francis Group
http://taylorandfrancis.com

Chapter 8

Narrative Descriptions Crime Scene Notes and Reports

Key Terms

Introduction
Characteristics of the scene
Conditions of the scene
Environmental conditions
Entry and exit points
Scene documentation

Learning Outcomes

1. Identify three characteristics shared by crime scene notes and a crime scene report.
2. Explain how crime scene notes support the long-term investigation.
3. Determine three items a crime scene report should *not* contain.
4. Explain the necessity of creating a methodical and ordered crime scene report.

8.1 Creating a Field Note Document Template

Objective

- Students are to create a field note document template to serve as the framework for crime scene report narratives.

Concept Overview

Crime scene notes and reports are the narrative forms of documentation and are pertinent to all cases. The mission of the crime scene technician is to take notes and create reports that are detailed, accurate, and understandable. Crime scene notes are the cornerstone of all investigations and should reflect an accurate description of all observations and actions taken at the scene. Ultimately, this accumulation of relevant facts, observations, and actions should be organized and placed in a final report. The crime scene report should *not* contain a cursory discussion of only the focal points found within the crime scene. Rather, the scene and its evidence should be described in adequate detail to relay the important characteristics of the scene and the interrelationships of the evidence within the scene. Additionally, a crime scene report should not be a narrative stating why the suspect is guilty. Crime scene reports should stay focused on the scene investigation, the evidence of the scene, and provable facts. Crime scene reports should not solely contain descriptions of evidence limited to those that support a hypothesis. Instead, reports should contain unbiased information concerning all physical evidence of the scene and evidence related to the investigation, regardless of whether that evidence is in support of or direct opposition to investigative theories.

A crime scene report should be organized, which can be difficult when faced with a complex crime scene. The following format is suggested for addressing all necessary information and may be altered based on the complexity of the scene.

Format:

- Introduction
  - Who worked the scene, location, date, time, reason for the examination.
- Characteristics of the scene
  - General description of the area and associated features, such as doors, windows, and geographical features (exterior scenes). These are static and stable items that will not change.
- Conditions of the scene
  - Specific conditions that pertain to the investigation, such as cleanliness, level of disarray, and descriptions of evidentiary items.
- Environmental conditions
  - Weather or scene conditions noted at the time of the investigation.
- Factors relevant to entry and exit
  - Addresses both known and possible avenues of entering and exiting the scene.
- Scene documentation
  - Describes the basic efforts taken to photograph and sketch the scene. This may include equipment used and how the documentation was created.
- Collection of physical evidence
  - A description of all physical evidence located at the scene. If an evidence log has been created, a cross-reference may be used.
- Search for latent prints
  - Describes the areas that were processed for latent prints, including both positive and negative results.
- Additional examinations
  - This area is dependent on the type of crime scene that is present. Examinations may include, but are not limited to, fire patterns at an arson scene and bloodstain patterns at a violent crime scene.

Materials

- Writing utensil

Procedure

1. Examine the subjects/categories in the Data Worksheet.
2. In the Field Note Document Template Outline, place the subjects/categories in the appropriate sections:
   - Introduction
   - Characteristics of the scene
   - Conditions of the scene
   - Environmental conditions
   - Factors pertinent to entry and exit
   - Scene documentation
   - Collection of physical evidence
   - Search for latent prints
   - Additional examinations
3. Maintaining the order of the nine-section format, create a field note template.
4. Complete the Post Lab Questions.

Data Worksheet

Field Note Subjects/Categories	
Time en route	Doors/windows secured
Designated diagram area for sketching decedent	Marbling
Type of camera used to capture photographs	Indoor vs. outdoor scene
Bloodstain pattern analysis	Outdoor temperature
Success in fingerprint development and location of development	Seized vehicles
Collected clothing	Interior scene lighting
Offense/investigation type	Jewelry
Footwear/tire tracks	Location
Ambient temperature of interior scene	Trajectory analysis
Collected gunshot residue (GSR) kit	Petechial hemorrhaging
Creation and inclusion of photography log	Notified by
Available light: dawn, dusk, daylight, night	Thermostat setting
Decomposition	Collected DNA samples
Videotaping (type of camera used)	Investigator
Construction of indoor scene: brick, wood, metal, other	Development methods used
Weather: foggy, clear, cloudy, rainy, sunny	Rigor mortis
Collected blood evidence samples	Creation of rough sketches
Physical description of decedent	Time notified
Use of specialty equipment, i.e., alternate light source	Clothing
Descriptors of outdoor scene: wooded, partially wooded, open field	Position of decedent
Presence/absence of forced entry	Lividity
Collected fingernail scrapings/cuttings	Date
Presence of pry marks/toolmarks	Exterior lighting and type
Compass direction indoor scene facing	Wounds
No success in fingerprint development	Time arrived
Type of structure: home, mobile home, business	Scars
Use of special photography techniques	Tattoos
Collected combed/pulled head hair	Insect/animal activity
Side of roadway indoor scene located	Blanching
Documentation of developed fingerprints/palm prints	
Collected firearms/firearm evidence	
Chemical enhancement methods employed	
Exterior color of indoor scene: primary and trim	
Areas examined for fingerprints/palm prints	
Distance from roadway of indoor scene	
Skin slippage	
Exterior descriptors of indoor scene location	

Field Note Document Template Outline
Section 1: Introduction
Section 2: Characteristics of the scene
Section 3: Conditions of the scene
Section 4: Environmental conditions

(*Continued*)

Field Note Document Template Outline
Section 5: Factors pertinent to entry and exit
Section 6: Scene documentation
Section 7: Collection of physical evidence
Section 8: Search for latent prints
Section 9: Additional examinations

Post Lab Questions

1. What should a crime scene report *not* contain?
2. How could a template help when taking notes at a crime scene?
3. Describe the difference between the characteristics and the conditions of the scene.
4. Why is an introduction important to begin a report?
5. What three characteristics should a good narrative display?

Bibliography

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Chapter 9

Light Technology in Crime Scene Processing

Key Terms

Alternate light source (ALS)
Radiant energy
Visible light
Electromagnetic spectrum
Nanometer
Reflection
Absorption
Transmission
Conversion
Luminescence
Fluorescence
Phosphorescence
Short-wave ultraviolet light
Long-wave ultraviolet light
Infrared light

Learning Outcomes

1. Explain how radiant energy is beneficial in crime scene processing.
2. Describe the relationship between the electromagnetic scale and radiant energy.
3. List the components needed to photograph a fluorescing evidentiary item and explain how those components must be arranged for proper image capture.
4. Describe the benefits and limitations of infrared light in crime scene processing.
5. Explain the considerations when selecting an alternate light source (ALS) for purchase/use.

9.1 Scene Processing with an ALS

Objective

- Describe the four ways light can react when it strikes an object.
- Explain how fluorescence occurs and how it is beneficial in crime scene processing.
- Describe how the different wavelengths of ultraviolet light can be used in crime scene processing.

Concept Overview

Light is a valuable tool in crime scene investigation. Without adequate illumination of a crime scene, an investigation is compromised, because evidentiary items will not be seen and therefore not collected. Such a lackluster investigation can result in the guilty remaining free to offend again. There is no rival to clean white light in its ability in assisting with searching for and visualizing evidence.

Visible light is radiant energy that we see all around us in the form of colors. However, it is a very small portion of all the radiant energy represented on the electromagnetic spectrum. Radiant energy travels in waves known as electromagnetic waves; the various forms of radiant energy are characterized by their wavelengths: short, medium, and long. Thus, the electromagnetic spectrum is a continuum on which wavelengths of energy are arranged by their length. The electromagnetic spectrum includes gamma rays, x-rays, ultraviolet (UV) energy, visible light, infrared (IR) energy, microwaves, and radio waves (Figure 9.1).

Due to wavelength size, the nanometer (one billionth of a meter) is used to express the wavelength value or the length between the peaks of a wavelength of UV light, visible light, and IR light (Figure 9.2). Interestingly, there is an inverse relationship between wavelength and energy: the shorter the wavelength, the greater the energy; the longer the wavelength, the less energy that is present.

Generally, there are four actions that occur, separately or collectively, when light energy strikes an object. Two of those actions are *absorption* and *reflection*. When light energy strikes an object, it does so inclusive of all its primary colors: red, orange, yellow, green, blue, indigo, and violet. The object will absorb or take in the majority of the wavelengths striking it and reflect or reemit wavelengths. For example, identifying grass as "green" occurs because the grass has reflected energy wavelengths defined as the color green and absorbed all other wavelengths or colors. When all wavelengths of light are reflected, the color identified is white. When all wavelengths of light are absorbed, the color identified is black. When light can pass through an object, *transmission* is occurring. Transparent objects such as water and glass are examples through which transmission of a particular wavelength or color can be observed.

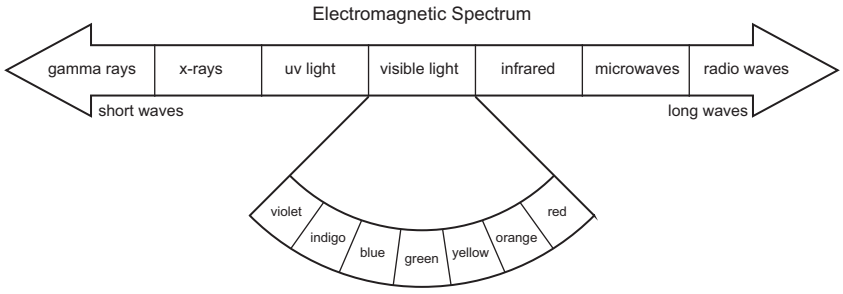


Figure 9.1
Electromagnetic spectrum.

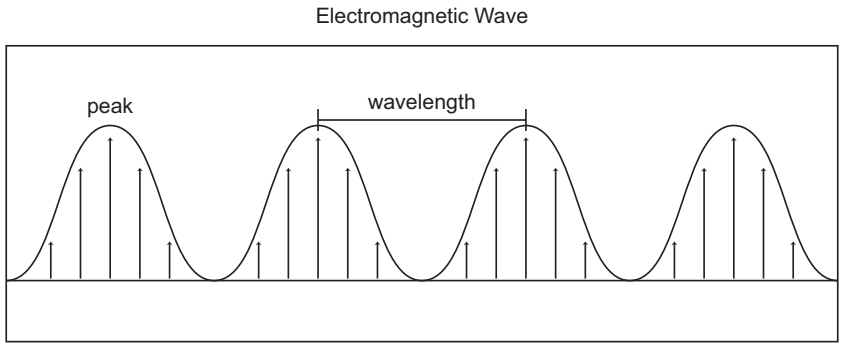


Figure 9.2
Electromagnetic wave.

Conversion occurs when a wavelength is changed to another wavelength of different length. An example of this is luminescence, which is the ability to emit light without the origin of heat, such as light or chemicals. Luminescence is a broad term that includes phosphorescence and fluorescence. Phosphorescence occurs when an object is stimulated by light, retains the received radiation, and after removal of the stimulation, continues to visibly glow or give off light in the wavelength in which it was converted. Fluorescence occurs when an object absorbs a stimulating light and converts it to a lower intensity (energy) and longer wavelength than that of the illuminating source. The resulting fluorescent light will differ in color from the stimulating light and emit a glowing appearance only during stimulation. Fluorescence as a property and characteristic is important in scene investigation and evidence processing and thus needs to be understood. Items typically collected as evidence, such as semen, saliva, and bone, fluoresce, and fluorescence is critical during evidence processing when using fluorescent powders and dye stains.

An alternate light source is a device that leverages fluorescence as it allows a specific wavelength of radiant energy to be emitted and used for the examination and processing of scenes and substrates. When employing an ALS, the choice of wavelength is critical as different objects will absorb light and fluoresce at different wavelengths. Thus, an investigator should view a scene or substrate with multiple wavelength/barrier filter combinations to determine which will allow maximum fluorescence of the scene/substrate and minimum fluorescence of the scene/substrate background. To view the fluorescence of an object, an investigator must wear barrier glasses or use a barrier shield through which to view the object. The use of glasses/shields is imperative as they block out all wavelengths except that of the resulting fluorescent light. In short, without the use of barrier glasses or shield, the property of fluorescence will not be viewed. Barrier glasses/shields are of three colors: orange, yellow, and red. The decision as to which color to use is contingent upon the wavelength of light employed. The various combinations of wavelengths and barrier colors have differing visual results; the combination that provides optimal visualization is the desired combination, and this is based on training and experience.

To document fluorescence in a scene or of an object/substrate, it must be photographed. The manner in which the fluorescence is visualized, i.e., the wavelength of light and color barrier filter used, is also the manner in which photographic documentation is to be obtained. This means that the components and characteristics used to view the fluorescence are the same ones needed for the camera to capture the image as the eye sees it. First, the camera must be stabilized rather than handheld; this is typically done by mounting the camera to a tripod. As the camera acts as the eye of the viewer, it must be arranged so that the camera's lens "sees" through the barrier filter/shield. This can be achieved by affixing a barrier filter onto the camera's lens or by holding a barrier shield flush against the camera lens, preventing any ambient light from entering the lens. Next, the ALS must be positioned so that its emitted energy wavelength strikes the object/substrate but does not obstruct the "view" of the camera. As with all other physical evidence documented via photography, it is important to use a scale for size reference. To be visible in this type of photography, a fluorescent scale is used (Figure 9.3).

Wavelengths of light other than those of visible light are utilized in scene investigation and evidence processing. Ultraviolet light lies between 100 and 400 nm on the electromagnetic scale, just below visible light. Short-wave UV is used in Reflected UV Imaging Systems (RUVIS) to detect latent print deposits without traditional processing or development efforts. Long-wave UV can be used in the search for blood evidence. Blood does not fluoresce; rather, it absorbs the light and will appear black in color. Other biologicals, such as semen and saliva, will fluoresce without the use of a color barrier filter. Infrared light (700–2000 nm), which resides just above visible light, can be used in the examination of questioned documents to assess for forgery or in the occurrence of obliterations. It is also a stellar tool for the visualization of blood, soot, gunshot residue, and bruising. When viewed with IR light, they will appear dark with the background lighter in color. One of the limitations of using IR light is the unpredictability of successful visualization of evidence. This hinges on the reflective nature of the clothing/material being assessed, and this reflectivity is attributed to the dye(s) of the item. Another limitation in using IR light is documentation. IR photography is a true skill that requires training, practice, and patience. Traditional IR photography is conducted with a digital camera, R72 filter, tripod, and IR light source. Visualization and identification of evidence is the first step in evidence collection. If evidence is not documented and collected, the investigative effort is in vain and investigations are negatively impacted. Technology, however, has advanced to the point where dedicated IR cameras are now available for those who can afford them.

As forensic science and the technology leveraged for it have advanced, investigators must use equipment that will assist them with evidence identification. Forensic/alternate light sources are such tools. When working to integrate such equipment, it is imperative to make an assessment to determine which type of ALS is needed based on the need for portability, ruggedness, capability, and cost.

Figure 9.3
Photographing fluorescence.

Materials

- Writing utensil

Procedure

1. Read the investigative report.
2. Using Table 9.1 as a resource, identify what evidence should be treated with light technology, and use the Assessment Chart to report that information.
3. Determine what wavelength and barrier filter color should be used on the identified evidence. Report that information in the Assessment Chart.

Investigative Report

On 9/15/2018 at 2:25 a.m., I, Investigator H. T. Johnson (#555), responded to a scene at 1545 Alberta Road. Initially the call was reported as a residence fire. After the fire department responded and extinguished a small fire on the exterior side of a utility building, law enforcement was requested to respond to a possible assault and sexual assault.

I requested that patrol officers on the scene separate the parties at the residence until I could obtain statements from them. I entered the residence and observed what appeared to be disarray and signs of altercation. A coffee table in the center of the room was broken, as was a barstool near the counter of the kitchen bar that separated the living room and kitchen area. The walls of the living area were white, and I noted what appeared to be bloodstains on them. There was also what appeared to be blood on the living room flooring. The couch and chair in the living room were of dark-colored cloth, which prevented me from determining whether there was staining consistent with blood on them.

TABLE 9.1
ALS Wavelength and Barrier Filter for Evidence Assessment and Processing Resource

Evidence Type	Wavelength	Barrier Filter
Blood	Long-wave UV (365–415 nm)	UV glasses
Semen	Long-wave UV (365–415 nm)	UV glasses
Saliva	Long-wave UV (365–415 nm)	UV glasses
Bite marks	450 nm	Yellow
Bruises	450 nm	Yellow
Biological fluids	455 nm	Orange
Hair	White light	None
Tooth/bone	455 nm	Orange
Fibers	490–520 nm	Orange
Subcutaneous bruising	570–700 nm	Orange/red
Questioned documents—inks	Infrared light (700–2000 nm)	None
Blood	Infrared light (700–2000 nm)	None
Soot	Infrared light (700–2000 nm)	None
Bruising	Infrared light (700–2000 nm)	None
Gunshot residue	Infrared light (700–2000 nm)	None
Processing	**Wavelength**	**Barrier Filter**
Ardrox (dye stain)	435–480 nm	Yellow
RAM (dye stain)	415–485 nm	Orange
MBD (dye stain)	415–505 nm	Orange
MBD (dye stain)	415–470 nm	Yellow
Rhodamine 6G	495–540 nm	Orange or red
Basic Yellow 40	415–485 nm	Yellow or orange
Fluorescent powder	455–470 nm	Orange
(green, yellow, orange, red)	UV light	Safety glasses
	470 nm	Yellow

Walking further into the residence, I discovered an African American female, later identified as Janet Johnson, sitting on the floor in a small bedroom on the west side of the residence. She appeared disheveled and upset. I identified myself and asked her if she needed help. She responded that she did. While speaking with her, I noted that she appeared to have some bruising on her arms and face. Her eyes appeared bloodshot and her upper lip was cut and swollen. I called for an ambulance to respond to the residence. While awaiting their arrival, Ms. Johnson relayed the following. She came to the residence at approximately 9:00 p.m. to visit her cousin, Jacquleen, and show her the new shoes she had bought from the mall. At approximately 9:30 p.m., Jacquleen's boyfriend, Treymond, and several of his friends also came to the residence. Everyone began to drink alcohol and "party." One of Treymond's friends started talking to Janet. After a while he and Janet went into another room of the residence. The male became aggressive and tried to take Janet's clothes off. Janet said she needed to go home and tried to leave the room. He blocked her exit. At this time, I noted Janet was uncomfortable and hesitant to discuss the matter further. Also at this time, EMS arrived. I escorted Janet out to the ambulance so she could be assessed. During that time, I returned to the room in which I had found Janet. I observed that in the southwest corner of the room there was a bare boxspring and mattress on the floor. The mattress was askew and partially off of the boxspring. I also noted what appeared to be moist areas and hairs/fibers on the mattress. On the bedroom floor, I noted there was a 40-ounce can of "King Cobra" beer on its side. I also observed a plastic "Shoe World" bag on the floor with a closed shoe box inside it. At this time EMS Medic Z. Taylor came to the door of the bedroom. He said that during his assessment of Janet that he noted extensive bruising on her as well as what appeared to be bite marks. He also said that Janet stated she had been sexually assaulted and she was going to be transported to the hospital. I told Medic Taylor that I or another detective would go to the hospital to follow up with Janet.

I continued the walk-through and looked into a room on the east side of the residence. There were boxes with paper in them and several printing machines connected to several computers. On the floor, I observed several checks in the names of different people for fairly large sums of money. The sole bathroom of the residence was unremarkable. I went back to the living room to access the kitchen/dining area. I observed pizza boxes open with a few slices in each. There were numerous cans and bottles of alcoholic beverages on the kitchen counter. Two beer cans on the dining table were on their side, and liquid that had the odor of beer was on the dining table. In the corner of the dining area, I saw a crumpled black trash bag. On the floor near the leg of one of the dining chairs, I observed a fired cartridge case.

Completing the walk-through, I went outside to speak with Jacquleen. According to her, she lives at the residence with her brother, James. She has been staying at the residence alone for several days, because James is out of town with a friend. She stated that on this evening her cousin, Janet, came over for a visit. Jacquleen's boyfriend, Treymond, came over with his friends also and they visited together. She said everything was good for a while but then Treymond's friends started arguing and getting "crazy." One of the males got upset and put a bag over the head of another male's head. Jacquleen said at that point she isn't quite sure what happened, but they started wrestling and fighting and her barstool and table were broken during this time. She said she knows the bag came off the male's head, because right after it did she saw someone pull out a gun and fire it. I asked her if anyone had been shot. She said no but that there is a hole in her couch. I asked her who fired the gun; she said she didn't know. I asked her who the males with Treymond were. She said she has seen them before, but she does not know their names. She also said that after the gun was fired some of Treymond's friends left the residence. She said a short time later she heard sirens, and a fire truck showed up. She was told that someone had started a fire at the shed by the house. I then asked her about Janet and where she was during the events of the night. Jacquleen said she wasn't sure, but that she saw Janet talking to one of Treymond's friends and thought they had left together.

After speaking with Jacquleen, I approached Treymond to get a statement. He refused to speak with me or make a statement. I encountered the same response from Marcus Washington, who was one of the males in the residence that evening.

CSI M. Kelly (#6502) arrived to investigate and process the scene at approximately 3:00 a.m. I relayed all information to CSI Kelly. The witnesses on scene were identified and their contact information was recorded for case follow-up. At approximately 3:15 a.m. I went en route to the hospital to follow up on Ms. Johnson.
End Report.

H. T. Johnson, Detective

Assessment Chart

Evidence	Wavelength	Barrier Filter

Post Lab Questions

1. Why is the use of light important in crime scene investigations?
2. Define *absorption* and *reflection*.
3. What is the difference between phosphorescence and fluorescence?
4. What is an alternate light source? Why is it used?

9.2 Photographing Fluorescent Evidence

Objective

- Understand the importance of documenting evidence enhanced with light technology.
- List the equipment needed to properly capture a fluorescent image and describe how the equipment is arranged.

Concept Overview

Investigative evidence, regardless of the manner in which it is detected or visualized, is crucial. For evidence to be meaningful and significant in an investigation, it must be properly documented. When documentation does not occur and, in many instances, when it does not occur properly, evidentiary items fail to provide the meaning they truly have and bear on the case. Further, juries during trial may not be shown such evidence; this affects their determination of guilt or innocence.

Light technology as a tool in forensic investigation is significant in the opportunity it provides investigators to detect and collect evidence. However, documentation of that evidence must be carried out. Evidence that requires an alternate light source for visualization also requires an ALS for documentation. There are several subsets of the electromagnetic spectrum utilized for evidence detection as well as processing. Ultraviolet light, infrared light, and the property of fluorescence in the visible light spectrum all have applicability, and each has a specific process by which evidence is documented via its application. It is imperative that the documentation process be known and properly conducted by those responsible for this task. Training in this area for skill acquisition is essential, as is skill maintenance.

Materials

- Writing utensil

Procedure

1. Examine the provided illustration (Figure 9.4).
2. Label each item where indicated on the illustration and complete the follow-up imperative.
3. Complete the Post Lab Questions.

Figure 9.4
Photographing fluorescence.

Post Lab Questions

1. Explain the arrangement of the equipment in the illustration.
2. How does this arrangement enable the capture of fluorescent images?

Bibliography

Gardner, Ross M., and Donna R. Krouskup. 2018. *Practical Crime Scene Processing and Investigation*. 3rd ed. Boca Raton, FL: CRC Press.

Chapter 10

Basic Skills for Scene Processing Fingerprint Evidence

Key Terms

Latent
Substrate
Patent
Plastic
Porous
Nonporous
Cyanoacrylate ester
Fuming tank
Alternate light source
Electromagnetic spectrum
Nanometer
Reflection
Absorption
Transmission
Conversion
Luminescence
Fluorescence
Phosphorescence
Barrier glasses/shields
Diopters

Learning Outcomes

1. Identify the four basic surface characteristics that help define the method used to process fingerprints on those surface types.
2. Successfully capture macro photographs of developed fingerprints.
3. Execute techniques involving powder/brush processing, cyanoacrylate ester fuming, and chemical processing for print development.

10.1 Capturing Examination-Quality Fingerprints

Objective

- Discuss the importance of assessment and documentation in regard to processing.
- Explain what an examination-quality photograph is.
- Explain why the camera must be stabilized in macro photography.
- Describe what a fingerprint should look like in the camera's frame when taking a macro photograph.

Concept Overview

As there are various types of physical evidence, there are various modes of processing them. The first step of any processing methodology is visual assessment. Regardless of the other processing steps, which are contingent upon the specific evidentiary item, the methodology always includes documentation of some manner. It is important for the investigator and processor to understand that different modes exist, why they exist, how they are implemented, and that gross deviation from these processes will yield unsuccessful results (Figure 10.1). Knowledge of different processing modes should be accompanied by or shortly followed by specialized training in fingerprint development that focuses on skill acquisition. Once acquired, processing skills need to be maintained. If skills become dormant, it is critical that the processor practices on items that are as similar as possible to the evidentiary items slated for processing. Never does a processor want to learn or practice skills by processing actual case evidence.

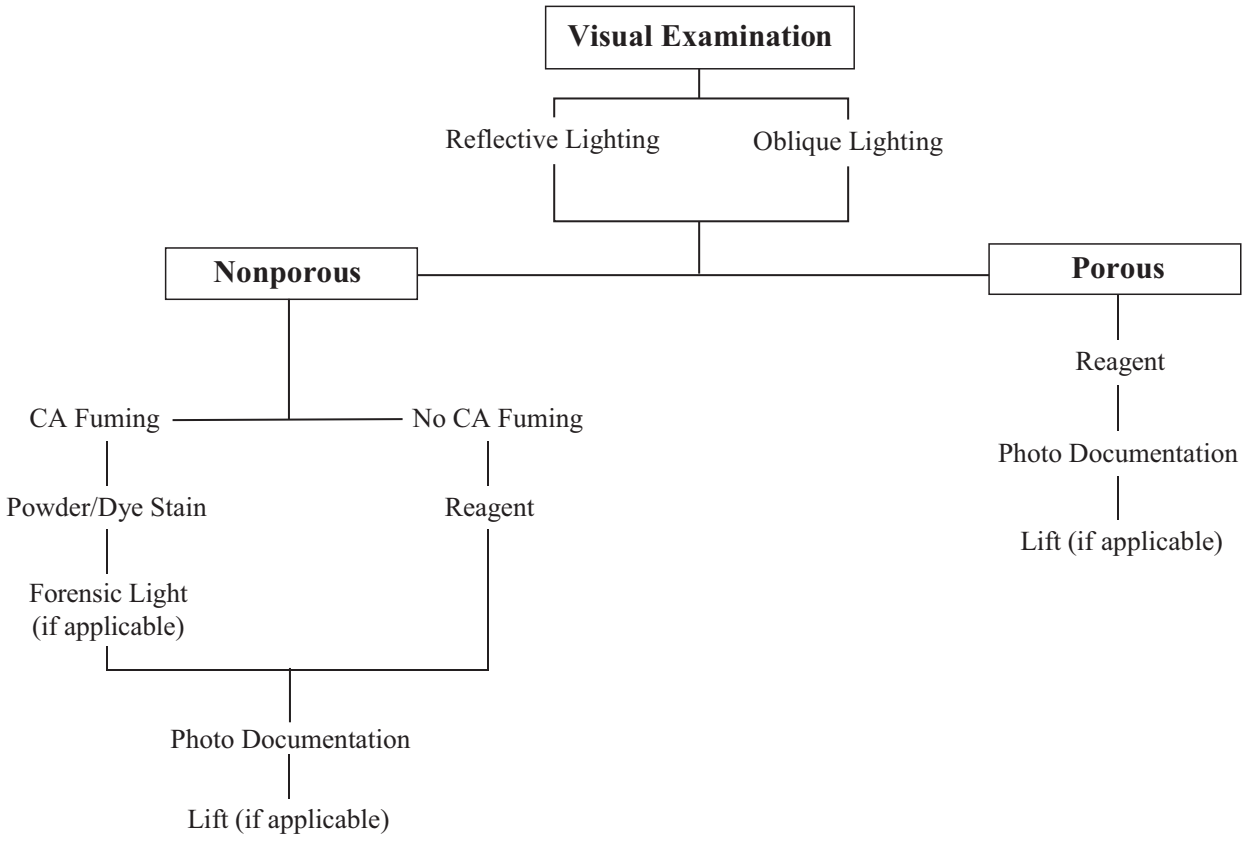


Figure 10.1
Modes of processing.

After fingerprints are developed, they must be documented. Fingerprints developed with powder may be lifted and placed on backing cards for preservation. Ideally, any fingerprint developed is photographed prior to attempting to lift it. This is because developed prints are not guaranteed to lift. They may lift partially or not at all, and the process of lifting, if not successful, may destroy the print. There are other modes of development in which lifting is not an option at all, and documentation must be in the form of photography.

Fingerprints are developed and collected in an effort to identify the actor(s) of an offense. Such identification is achieved through fingerprint comparison. Fingerprint examiners compare the known fingerprints of suspects with examination-quality photographs of developed prints. These types of photographs are captured through macro photography or extreme close-up photography. They are 1:1 or life-size images. This form of photographic documentation is different than general photography and requires specific equipment and procedures for image capture.

Ideally, a macro lens is used, which is designed specifically for this type of photography. If one is not available, diopters, which are less-expensive magnifying lenses, can be attached to the existing lens of the camera. For stabilization purposes, the camera should be mounted to a tripod. Hand-holding the camera is not an option, as these types of pictures tend to require long exposure times.

After the camera has been set up, the item bearing the developed print should be placed under the camera lens. When mounted on the tripod, the camera lens will only be several inches from the item and must be 90 degrees to the developed fingerprint. Camera settings should now be addressed. The ISO should be set to 100 or 200; this will prevent photo enlargements from being grainy. The camera's command dial should be set to either manual or aperture. Neither automatic nor program mode will suffice for these types of photographs. The specific aperture setting, which will be determined by the photographer, will depend on the shape of the object photographed. A print on a sheet of notebook paper does not need very deep depth of field. The lens may be fairly open via an aperture setting of f/8 or f/11. If the object has dimension or curvature, deep depth of field is needed. The aperture, or lens opening of the camera, will then be small, such as f/22. The deep depth of field will allow the entire print, as it is wrapped around or over an item, to be in focus. If a larger aperture was used to record a print on a curved surface, only a portion of the print would be in clear, sharp focus. The final setting is shutter speed. In aperture mode, this is set for the photographer by the camera. In manual mode, the photographer must determine it. For nonfluorescent prints, simply adjust the shutter speed until the exposure-level scale is 0.

After the camera has been stabilized and the camera's settings have been established, the print must be composed for capturing. When looking through the camera's viewfinder, the print should fill the camera's frame as much as possible. Also visible in the camera frame, there should be a reference scale lying parallel to the print. For many objects, adhesive scales work well. However, given the size of some objects or nature of their shape, sometimes these types of scales are not usable. Nonetheless, a scale is still required to be in the photograph. The photographer must now determine a method for placing a scale next to the developed print and on the same plane as the print. Placing the scale above or below the print's plane will result in distortion. (Helping hands devices, which are inexpensive and readily available at hardware and hobby stores, are excellent tools for this task.) After the print and scale have filled the camera frame, manually focus the image so that they are in sharp, clear focus.

Finally, use a remote means for recording the image. There are several reasons for this. First, hands-free image capture prevents camera movement, which will occur if manually depressing the shutter-release button. Second, the shutter speed for these types of images tends to be long; they could last from 1 second to multiple minutes. This may not seem like much time. However, when shutter speed falls below 1/30 of a second, and a person is hand-holding the camera, the resulting images will be blurry. Also contributing to long exposure times are the low ISO setting and the nearness of the camera lens to the item containing the developed print.

For hands-free image capture, the camera must have an internal timer, or a shutter-release cable needs to be used.

Materials

- Camera
- Macro lens or diopters
- Tripod
- Penny or dime
- Scale

Procedure

1. Gather the appropriate camera equipment needed to record examination-quality images:
   a. Camera
   b. Macro lens or diopters
   c. Tripod
   d. Scale
   e. Penny or dime
2. Stabilize the camera with a tripod.
3. Confirm that the correct lens or accessories are on the camera to capture extreme close-up photographs.
4. Use a penny or dime as the subject of the photograph.
5. Fill the frame of the camera with the coin.
6. Place a scale next to the coin (in the same plane), confirming that it will be in the recorded image.
7. Adjust the camera settings.
   a. Command dial: Manual or aperture mode
   b. ISO: 100 or 200
   c. Aperture: Contingent upon the shape of the object with the developed print
   d. Shutter speed: In manual mode, adjust until the exposure-level scale is 0
8. Set the camera's internal timer (or use a shutter-release cable) to prevent camera shake and blurry photos.
9. Review photographs for proper capture.
10. If photographs have deficiencies, retake them.
11. Complete Post Lab Questions.

Post Lab Questions

1. Why is it important to photograph items of evidence after processing?
2. What is the purpose of a macro photograph?
3. Why is it important to use a camera remote when conducting macro photography?
4. List and describe the equipment needed to capture a macro photograph.

10.2 Fingerprint Pattern Examination

Objective

- Identify the two main layers of skin.
- Describe the three main fingerprint pattern types.
- Describe various minutiae found in fingerprint patterns.
- Practice identifying the minutiae within a fingerprint.

Concept Overview

In crime scene investigation, fingerprints are one of the most desired types of evidence for recovery. They are considered valuable because they are individualizing, meaning they can identify an individual as the source of the evidence. The use of fingerprints as a form of identification has occurred for thousands of years. Fingerprints were used by the Chinese as a form of identification on documents in 300 B.C. and as signatures by Indian nobility in the 1600s.

The term *fingerprints* has become commonplace and refers to the pattern that is present on the tips or first joint of the fingers. The individualizing evidence that is on the soles of the feet and the palms of the hands, including fingerprints, results from *friction ridge skin*. Friction ridge skin forms at approximately 12 weeks on the human fetus. This skin has two main layers comprised of the dermis and the epidermis. The dermis is the innermost layer, while the epidermis is the outermost layer on which the ridges are visible.

Impression evidence derived from friction ridge skin is individualizing because of two important characteristics: uniqueness and permanence. The uniqueness of this type of skin is due to developmental factors and is based on randomness, genetics, and environmental stresses in the womb. To date, no two persons have been found to have the same friction ridge skin, including identical twins who have the same DNA. This skin is also permanent. The friction ridge skin a person is born with will remain relatively unchanged throughout a person's lifetime. Ridge shape and alignment remain constant. Alteration only occurs through injury or damage to the dermal skin layer. An injury would result in the scarring of the epidermis, while damage resulting from certain skin diseases may prevent the formation of friction ridges.

The ridges on the first joint of each finger form one of three distinctive fingerprint patterns. A person may have the same pattern on all five fingers, or they may have a mixture of two or all three patterns. The most common pattern is the loop (65%) (Figure 10.2), followed by the whorl (30%) (Figure 10.3), with the least common being the arch (5%) (Figure 10.4). Loops are characterized by a single delta located on one side of the print, which is accompanied by a looping feature that enters and exits on the same side of the print. Whorls are characterized by a circular pattern in the center of the print with two deltas, one on each side of the center circular pattern. Arches are characterized by a series of hill-shaped ridges of increasing height.

Within friction ridge skin are ridge characteristics known as minutiae or Galton's details (named after Sir Francis Galton). Minutiae consist of ridge endings, short ridges, dots, bifurcations, islands, trifurcations, and spurs (Figures 10.5 through 10.11).

Figure 10.2
Loop.

Figure 10.3
Whorl.

Figure 10.4
Arch.

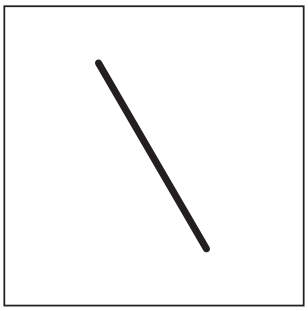


Figure 10.5
Ridge ending.

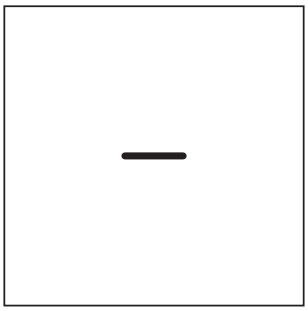


Figure 10.6
Short ridge.

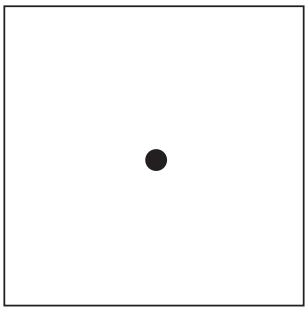


Figure 10.7
Dot.

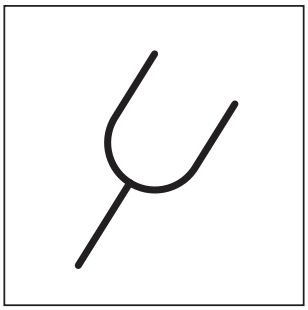


Figure 10.8
Bifurcation.

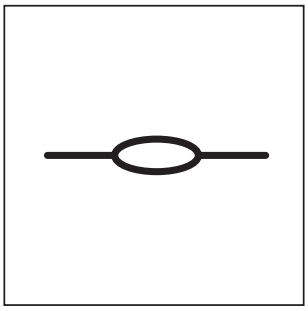


Figure 10.9
Island.

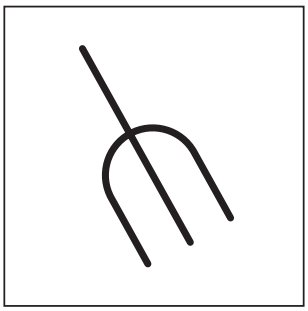


Figure 10.10
Trifurcation.

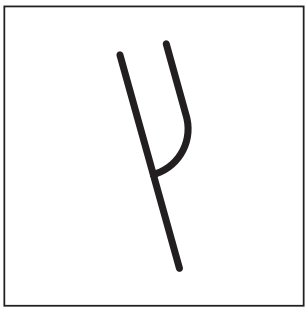


Figure 10.11
Spur.

ACE-V is the methodology used to examine fingerprints. The name of the methodology represents the steps in the examination procedure: analysis, comparison, examination, and verification. During the analysis phase, the examiner looks at three levels of detail in a recovered or developed suspect print. Level 1 detail is the fingerprint pattern (loop, whorl, arch). Through level 1 detail, potential donors may be eliminated. For example, a suspect print that is an arch could not have been created by a person who has loop patterns on all fingers. Suspect elimination is possible, but level 1 detail is not enough information to individualize the print to a specific person. Rather, the examiner must continue on to level 2 detail, which is the minutiae of the pattern or friction ridge skin. Analysis is of the ridge characteristics, their location, their relative positions to each other, and explainable dissimilarities. Level 3 details are minute in size and include pores on ridges and the thickness of ridges. In the comparison phase, suspect ink prints are reviewed for elimination or inclusion for the next phase. In the evaluation phase, the recovered/developed print and suspect inked print(s) are placed side by side and viewed under a loupe or magnification lens. Through this side-by-side analysis, the examiner seeks to find similarities and dissimilarities. During the evaluation phase, an opinion is formed as to whether a person is or is not the donor of the print in question. The final phase of the methodology is verification. Another examiner conducts an independent analysis and offers an opinion concerning identification. This is critical, as verification can reduce erroneous identifications and prevent self-verification.

Due to the value of friction ridge impression evidence and its potential ramifications for those who are identified as donors of suspect prints, print examination is a critical task. The vast majority of the time, the clarity and quality of recovered and developed prints are not controllable by the processor. This is not so for collected inked prints from suspects. The clarity and quality of these prints are controllable by the collector. Care must be taken to use a minimal amount of ink to prevent filling the furrows of friction ridge skin, which will result in black smudges and no pattern or minutia reproduction. Using too much pressure during print collection will result in smudging and distortion of prints. Two types of fingerprint impressions will typically be collected: rolled and plain. Rolled impressions are collected by rolling each finger, beginning with the right thumb, nail to nail, recording just below the first finger joint. Plain impressions are collected by simultaneously pressing inked fingers onto a fingerprint card. The thumb is recorded in the same manner, but on a separate, designated area of the card.

While ink fingerprinting is still largely used today, computerized alternatives do exist. Live Scan is a computer-based program that involves rolling or touching the fingerprint on a glass screen while a computer system records the ridge detail on the finger. The fingerprints are then saved as images and can be used for comparison.

Materials

- Writing utensil

Procedure

1. Create a workstation using butcher paper or a similar material to cover the work area surface.
2. Gather the following materials for your workstation.
   - Balloon (uninflated)
   - Ink pad
   - Permanent black marker
3. Slightly inflate your balloon.
4. Using the ink pad, apply ink to one of your fingers. *Do not* over-ink your finger or the print will smudge.
5. In a straight, down and up motion, place your inked finger on the balloon to apply a print. *Do not* attempt to roll the print.
6. Allow the ink on the balloon to dry.

7. Fully inflate the balloon.
8. Identify the fingerprint pattern on the balloon.
9. Use the marker to circle and label various minutiae in the fingerprint pattern.
10. After completing your print and notating the information in print 1 of your Evaluation Worksheet, trade balloons with a fellow classmate.
11. Examine their print and identify, circle, and label minutiae in the print that were not already identified.
12. Notate the information in print 2 of your Evaluation Worksheet.
13. Draw a replication of your plain fingerprint in the sketch canvas provided.
14. Complete Post Lab Questions.

Evaluation Worksheet

Print 1:
What is the fingerprint pattern? Loop Whorl Arch
Notate the number of each type of minutia in the print that is on the balloon:

Bifurcation: _____
Dot: _____
Ending ridge: _____
Island: _____
Trifurcation: _____
Short ridge: _____
Spur: _____

Print 2:
What is the fingerprint pattern? Loop Whorl Arch
Notate the number of each type of minutia in the print that is on the balloon:

Bifurcation: _____
Dot: _____
Ending ridge: _____
Island: _____
Trifurcation: _____
Short ridge: _____
Spur: _____

Sketch Canvas

Post Lab Questions

1. Was it difficult to identify the minutiae in your print? Why or why not?
2. How many different minutiae were identified in your print?
3. Were there any similarities and/or differences between prints 1 and 2? If so, describe?
4. What does ACE-V stand for?
5. Name the three basic fingerprint patterns.
6. What does level 3 detail of the analysis phase encompass?

10.3 Cyanoacrylate Ester Fuming and Fingerprint Powder

Objective

- Develop good techniques for processing and lifting latent prints using cyanoacrylate ester fuming and black powder techniques.
- Understand the principles regarding cyanoacrylate ester fuming.
- Practice both black powder processing and superglue fuming (with subsequent black powder processing techniques), using various brush/powder combinations on the objects/surfaces provided.

Concept Overview

There are three types of fingerprint impressions: latent, patent, and plastic. The term *latent* means hidden or invisible. This type of print requires assistance, such as powder or chemical application, for visualization. Fingerprint and friction ridge skin impressions are developable, because contact between friction skin surfaces and a substrate can result in residue deposits. The components of the deposits from friction ridge skin are water (98%) and nonorganic compounds, salt, amino acids, and oil (2% combined). The nonorganic components of the residue are the targets of the development reagents. When possible, all developed prints should be photographed prior to any lifting attempts, as the lifting process may result in a partial lift or in the destruction of the print without any success in lifting. Photography is the means of preservation for prints that are developed through chemical means, because these prints cannot be lifted with tape.

There are occasions when the residue deposit is very heavy. The use of reflective lighting can allow for the discovery of contacted areas on a substrate (an object on which a print is deposited), permitting the processor to view the area and to know where to begin the development process. Reflective lighting is a powerful, yet simple tool that can be used on objects that have a reflective quality. The light source of a room, such as an overhead light fixture, is used for this technique. Although any type of light will suffice, fluorescent lighting is best. The substrate is held, with gloved hands, by its corners and edges and moved in various directions to allow the overhead light to fall on it. The light will reflect on the object's surface and may reveal latent impressions.

Patent prints are those that are visible to the unaided eye. This visibility is due to a contaminate on the friction ridge skin such as grease, paint, or blood. Although patent prints are visible without processing, enhancement chemicals may be applied for additional development or better visualization. Enhancement chemicals applied to bloody prints react to the heme or protein of the blood. Preservation of these prints is documented through photography, as they cannot be lifted with tape.

Plastic prints are visible impressions in pliable or malleable substrates such as soap or wax. Preservation of these prints is through photography, as they cannot be lifted with tape.

Fingerprints can be found on a variety of mediums, which have been divided into five categories:

- Porous: Paper products such as cardboard and untreated wood
- Nonporous smooth: Finished or painted surfaces such as glass and the majority of plastics
- Nonporous rough: Textured surfaces such as vinyl or leather

- Adhesive: Items that contain a matte and/or a "sticky" side
- Special conditions/surfaces: Processing bloody prints or human skin

Each surface has a unique set of challenges, and it is important to practice different techniques on various types of surfaces to be prepared for any type of crime scene processing.

Black powder processing is the most common type of fingerprint processing. This straightforward technique uses a brush and black powder to help visualize and obtain latent prints for analysis. However, developing a viable fingerprint is more difficult than one would think. Several problems can arise when processing for latent prints, such as overpowdering the latent print or using too much pressure when dusting for a latent print. Latent prints are delicate and can be easily damaged. It is very important to practice dusting for prints prior to working a crime scene. The application method for black powder is as follows:

1. Ensure that the fingerprint brush is clean and free of debris via visual examination.
2. Separate the brush bristles by spinning the brush.
3. Pour a small amount of powder onto a clean piece of paper.
4. Lightly tap the brush bristles into the powder.
5. Remove excess powder from the bristles by shaking the brush.
6. Apply powder to the item by twirling the brush in a circular motion (Figure 10.12).
7. When ridge detail appears, apply powder by moving the brush in the direction of the print's visible ridge flow (Figure 10.13).
8. Continue to develop the print until maximum contrast is reached (Figure 10.14). Surpassing maximum contrast will result in visible degradation of the print.

Figure 10.12
Powder application—brush in circular motion.

Figure 10.13
Brush motion follows ridge flow of developing print.

Figure 10.14
Developed print at maximum contrast.

Using a magnetic brush and powder is a fairly new alternative to the standard brush and powder techniques. The magnetic brush is composed of a magnetic rod that is covered by a sheath. The black powder is composed of the same elements as traditional powder with the addition of metallic shavings. This technique is just as effective as the standard brush and powder but eliminates some of the mess. The magnetic powder is applied to the end of the brush, creating a bulb of powder. The powder is then lightly applied across the print with the remaining powder deposited back into the container. This helps to limit excessive powdering and allows reuse of unused powder. The application method for magnetic powder is as follows:

1. Place the tip of the magnetic wand into the magnetic powder.
2. The magnetic powder will adhere to the magnet within the sheath of the wand to create the "brush."
3. Apply the powder to the item by moving the brush in a circular motion. (Only the powder should contact the item, not the bulb of the sheath. Contacting the wand to the item will destroy the print.)
4. When ridge detail appears, apply powder by moving the brush in the direction of the print's visible ridge flow.
5. Continue to develop the print until maximum contrast is reached. Surpassing maximum contrast will result in visible degradation of the print.

Camel hair brushes and marabou feather brushes may also be used. Camel hair provides a much stiffer brush and is generally used for cleaning off excess powder that has been applied to the print. Caution must be used when utilizing this brush. The stiff bristles, if used incorrectly, may damage or destroy delicate prints. Marabou feather brushes are a much lighter form of brush and should be used on delicate prints when fiberglass or camel hair is too abrasive. For example, a feather brush should be used to remove soot off of a medium containing an etched print that is covered in soot from a fire. Using any type of fingerprint brush is a skill that must be practiced. Employing one of the brushes discussed, without proper training and practice, could be detrimental to a case.

Cyanoacrylate ester fuming (CA fuming), also known as "superglue" fuming, is a technique commonly used to stabilize or harden the print in order for more rigorous processes to be conducted. CA fuming is conducted using an enclosed area such as a fish tank or cardboard box, a heating medium such as a hot plate, a small container of warm water, which produces the humidity needed in the reaction, and a small bottle of liquid superglue. Once the item has been placed in the enclosed area, superglue is placed on the heating element and a chemical reaction takes place. This reaction causes the polymerization of the fingerprint, which allows it to become hardened and stable for further processing. Do not overfume items as overfuming will prevent powder from adhering to the prints. Overfumed prints will be white in color and appear heavily coated. Caution therefore should be used to avoid inhaling CA fumes before removing items from the tank; vent them by slightly canting the tank lid to allow the fumes to escape. After removing objects from the tank's interior, turn the heating element off. To preserve prints developed with powders, lifting tape and lifting cards are used. There are various sizes of tape, ranging from 1- to 4-inch rolls. Each tape width brings its own difficulties, so it is important to practice with various sizes and be comfortable with each. Processors should

never use tape at a crime scene that they are unfamiliar with or have never used. Lifting prints is an art and a skill that must be honed. The method for lifting prints is as follows:

1. If the top layer of tape is dirty or smudged with powder, remove it in order to lift with clean tape.
2. Create a "handle" at the end of the tape by folding a ½-inch piece of the tape on itself. Students can avoid depositing their fingerprints on the adhesive side of the tape by only touching the handle and tape roll.
3. Anchor the tape (handle side) to the surface of the item 1 inch beyond the developed print.
4. Hold the tape roll up at a slight angle and apply the lifting tape over the print by using the index finger. Smooth the tape down onto the item's surface by moving your index finger through the print and toward the tape roll.
5. Eliminate air bubbles by rubbing over them with items such as an index card or eraser.
6. Use the tape roll to begin lifting the tape from the surface until reaching the handle and lifting the tape completely from the item's surface.
7. Using a card large enough to hold the developed print, anchor the handle side of the lifting tape onto the lift card. Smooth the tape down onto the card by using the index finger to move across the tape and toward the tape roll.
8. After applying the tape to the lift card, create another handle. With the handle pressed firmly against the tape roll, tear the tape. This allows the handle to stay attached to the roll, keeping it ready for immediate use.

After the lifting tape has been placed on the lift card, information must be written on the back side of the card for documentation purposes. This information includes:

- Name of processor
- Date/time
- Location from which the print was collected (object/substrate)
- Offense, case number, or title information provided by instructor

A diagram must also be created on the back of the card. The diagram depicts the object that was processed, and an X is placed on the diagram to illustrate the location on the object from which the print was collected. On the front of the card (print side), an arrow is drawn to indicate the orientation of the print (Figure 10.15).

Challenges involving large prints such as full palm prints or footprints are regularly encountered. When lifting large impressions such as these, strips of tape are used until the entire area is covered. The key to using multiple strips is to overlap them by at least a quarter inch. After covering the entire impression area, lift all tape strips simultaneously and apply them to an appropriately sized backing card, a piece of paper, or card stock.

Black powder processing, magnetic powder processing, and CA fuming are the cornerstones of crime scene processing. It is important during this exercise that you develop quality processing skills.

Materials

- Writing utensil

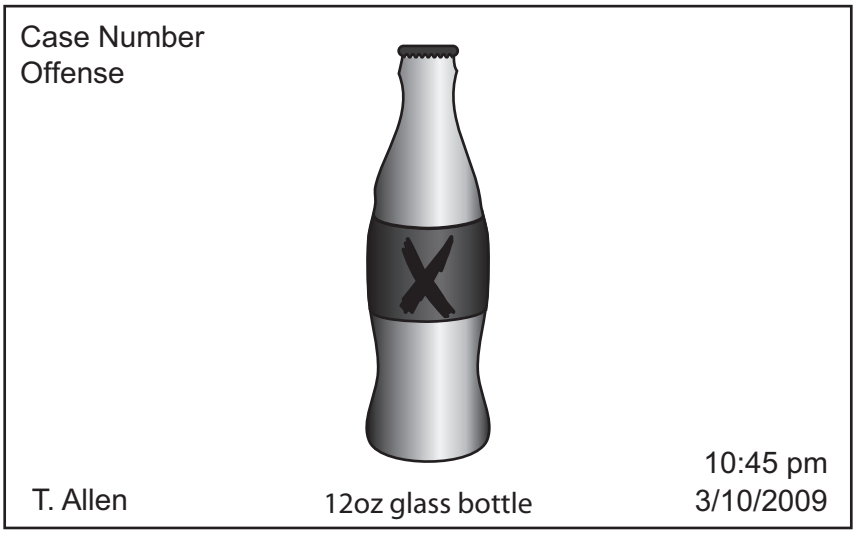
Procedure

1. Each student will create a workstation by covering their work area with butcher paper or other protective covering.
2. Use a fuming tank to fume an item with cyanoacrylate ester (at the instructor's discretion).

   Caution: Do not overfume the item.

   Warning! Do not inhale fumes. Always properly vent the tank before removing the item.

Front of Lift Card

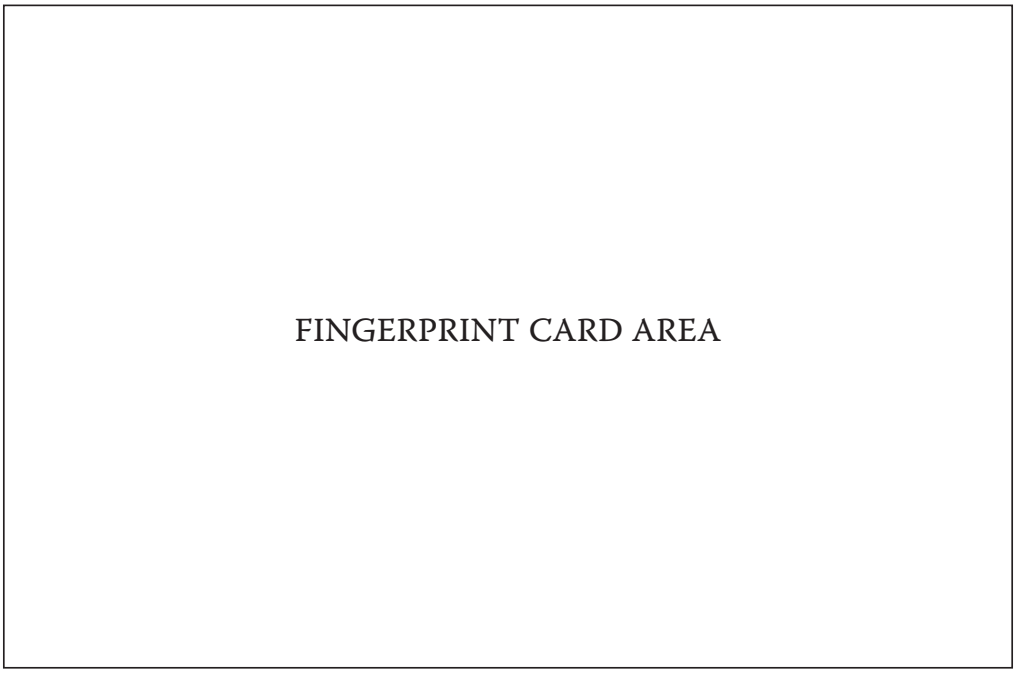


Back of Lift Card

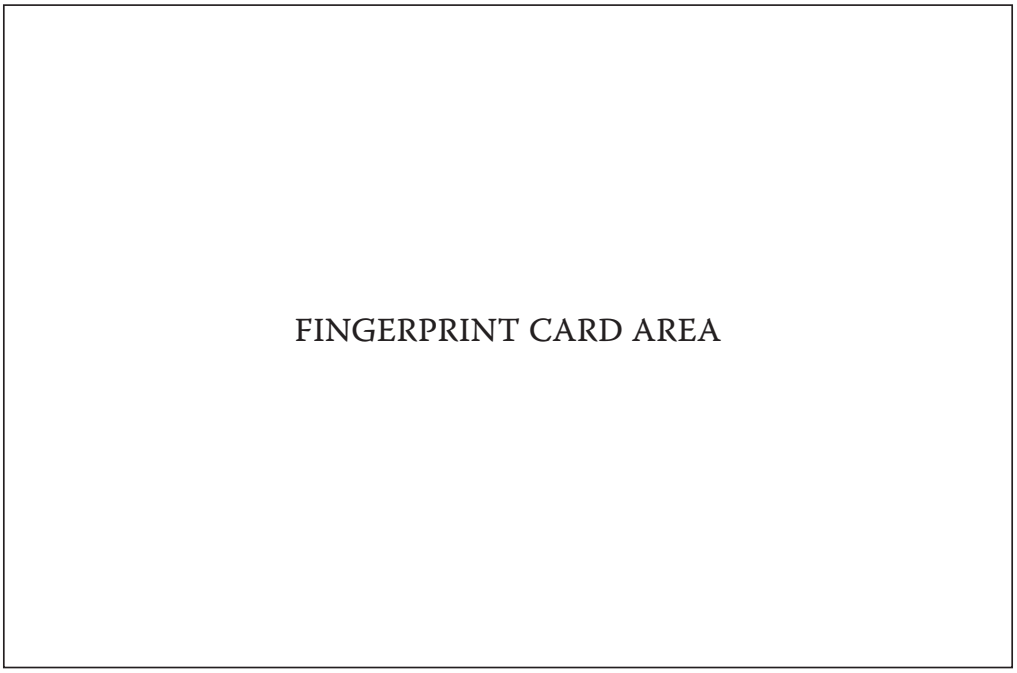
Figure 10.15
Front and back of lift card.

3. With a fingerprint brush, apply powder to the item to develop the fingerprints.
4. Lift developed prints with lifting tape.
5. Deposit prints on lifting card.
6. Complete Print Processing Worksheet.
7. Complete the Post Lab Questions.

FIBERGLASS BRUSH

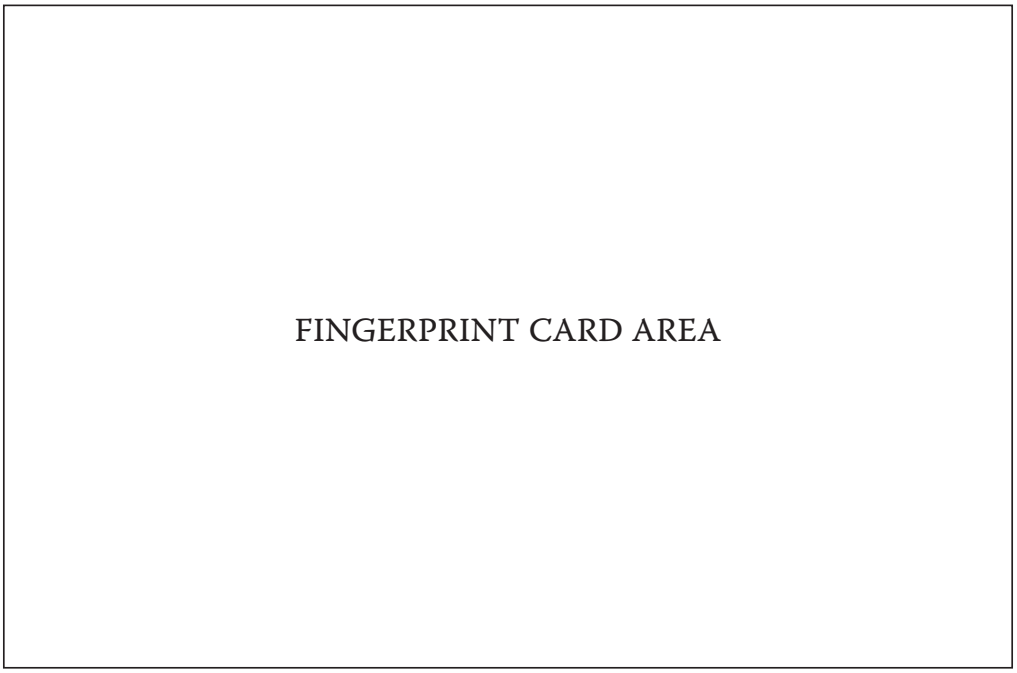


Powder type: Fumed: Yes No
Surface type:
Comments:

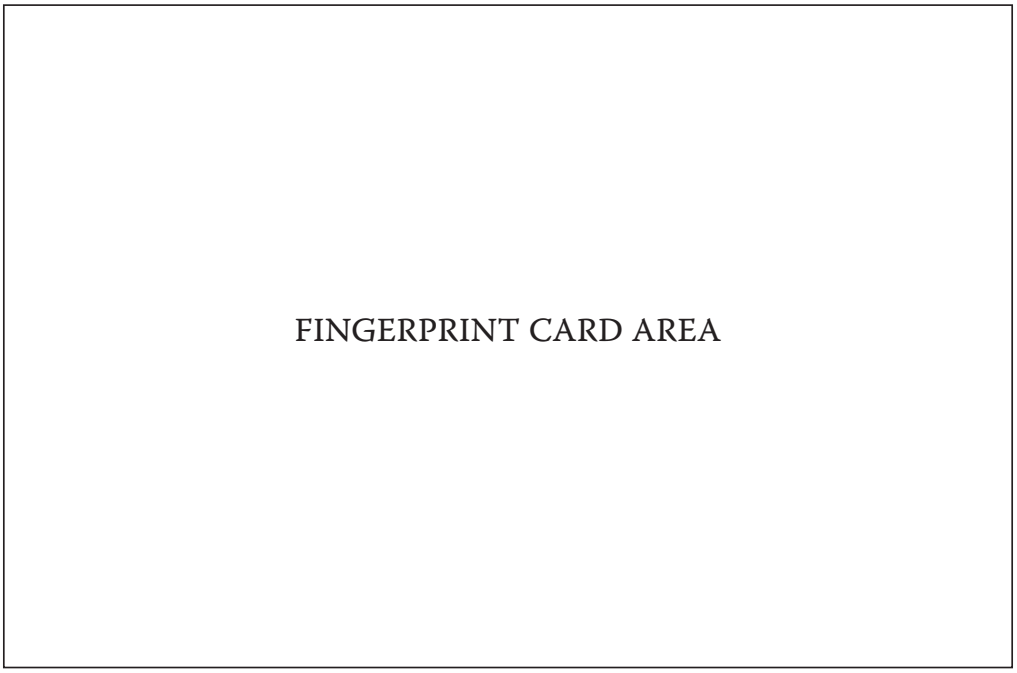


Powder type: Fumed: Yes No
Surface type:
Comments:

FIBERGLASS BRUSH

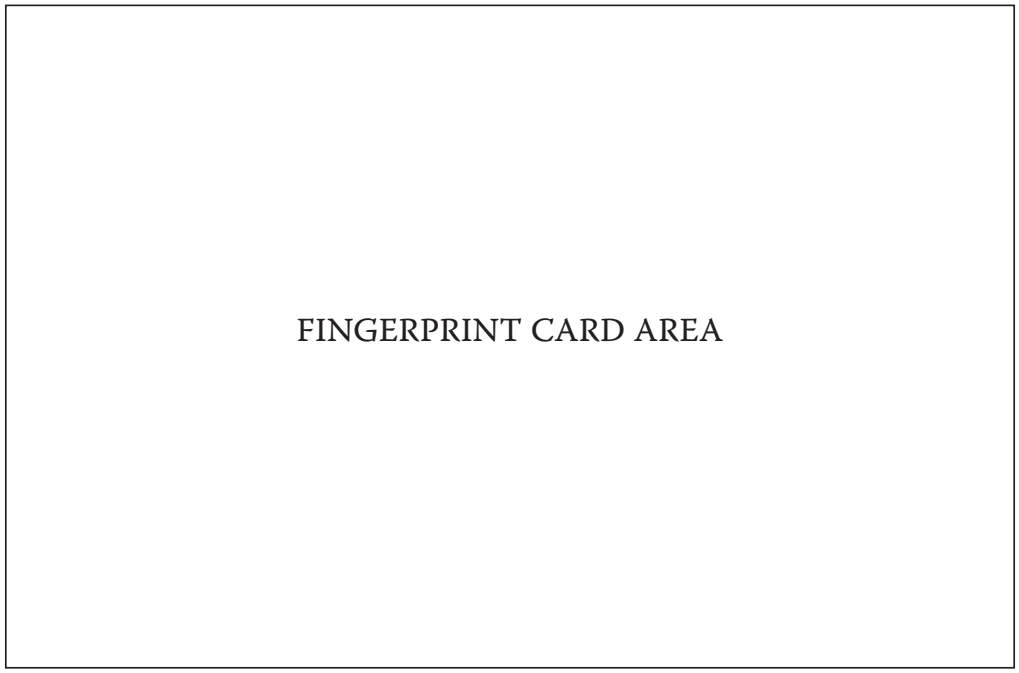


Powder type: Fumed: Yes No
Surface type:
Comments:

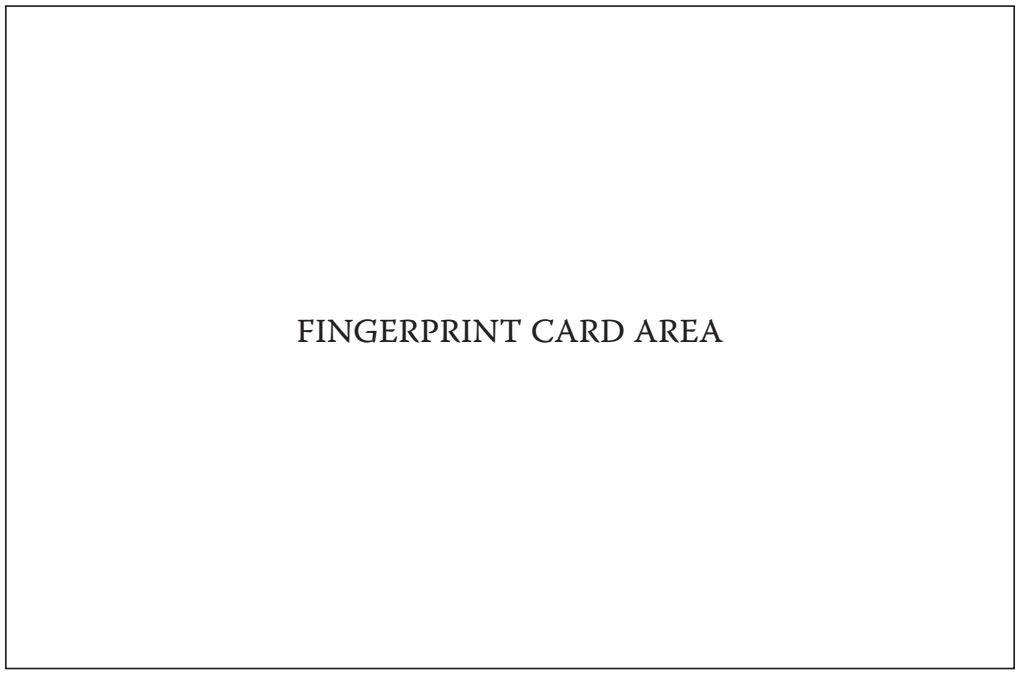


Powder type: Fumed: Yes No
Surface type:
Comments:

MAGNETIC BRUSH

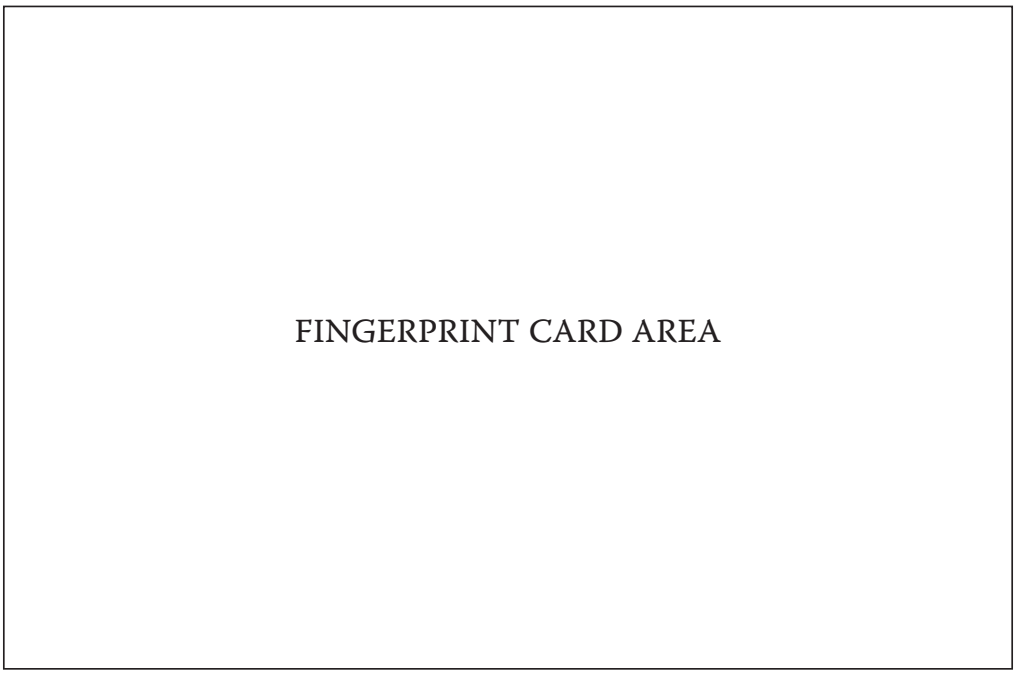


Powder type: Fumed: Yes No
Surface type:
Comments:



Powder type: Fumed: Yes No
Surface type:
Comments:

MAGNETIC BRUSH



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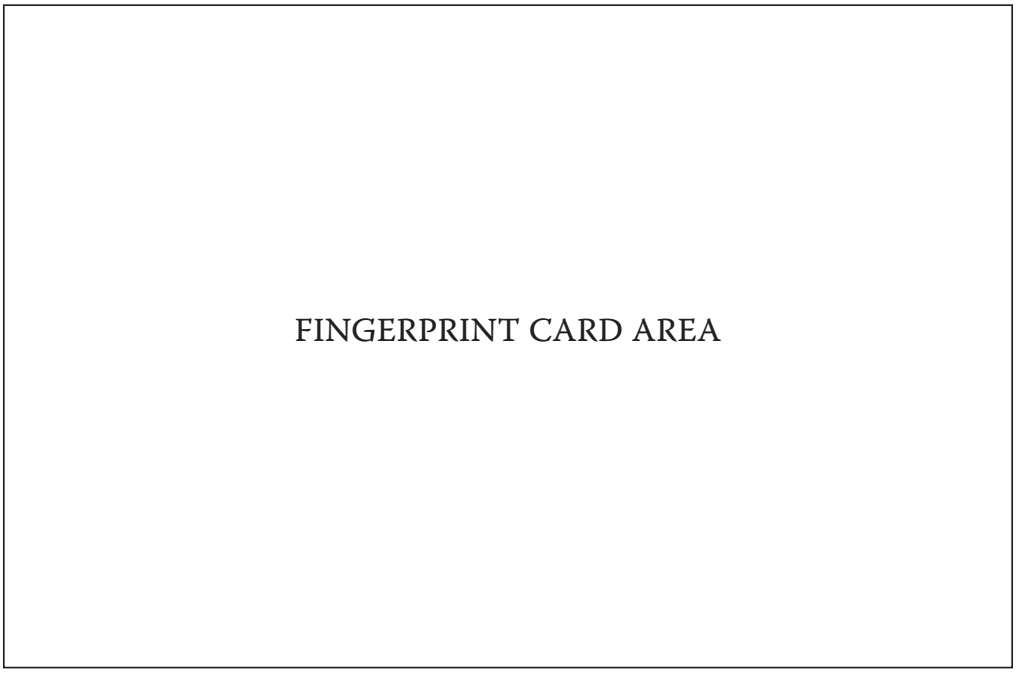
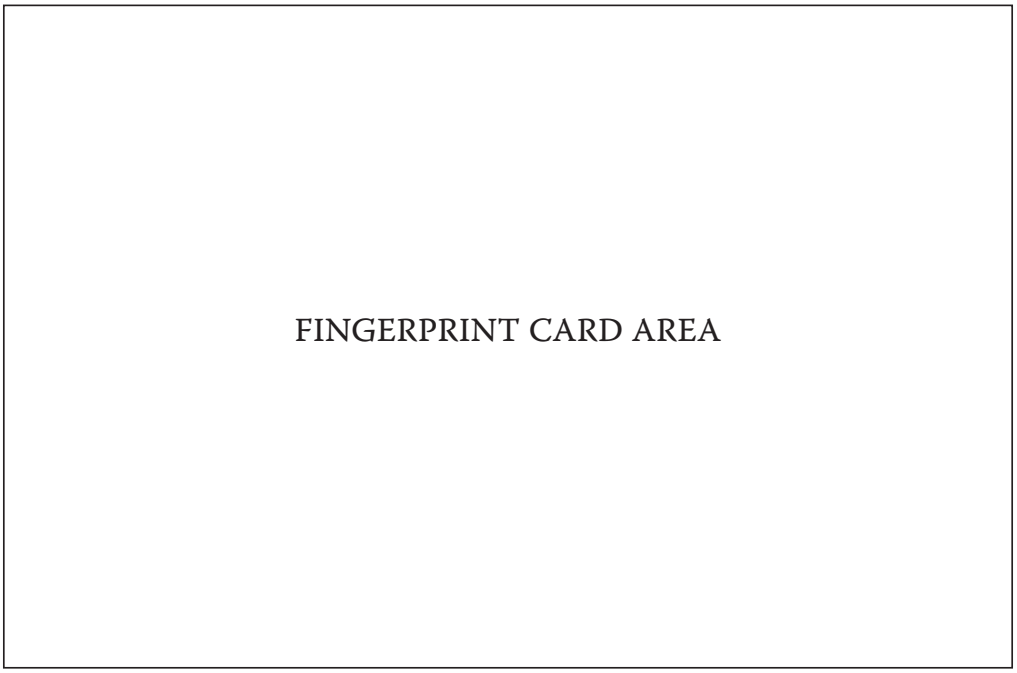
Surface type:
Comments:

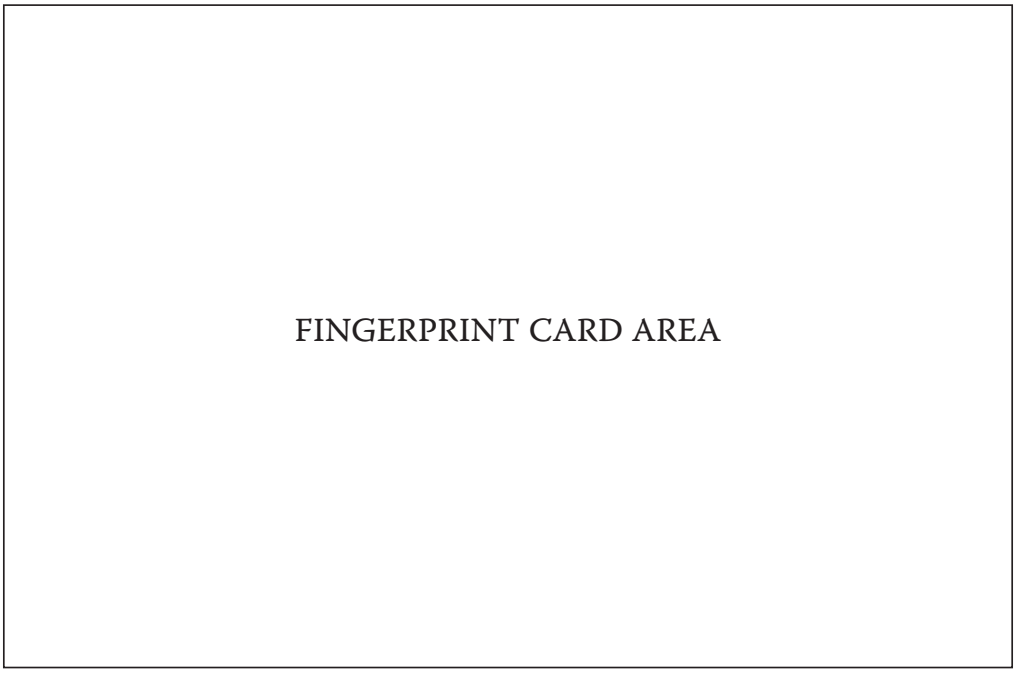


Powder type: Fumed: Yes No
Surface type:
Comments:

CAMEL HAIR BRUSH

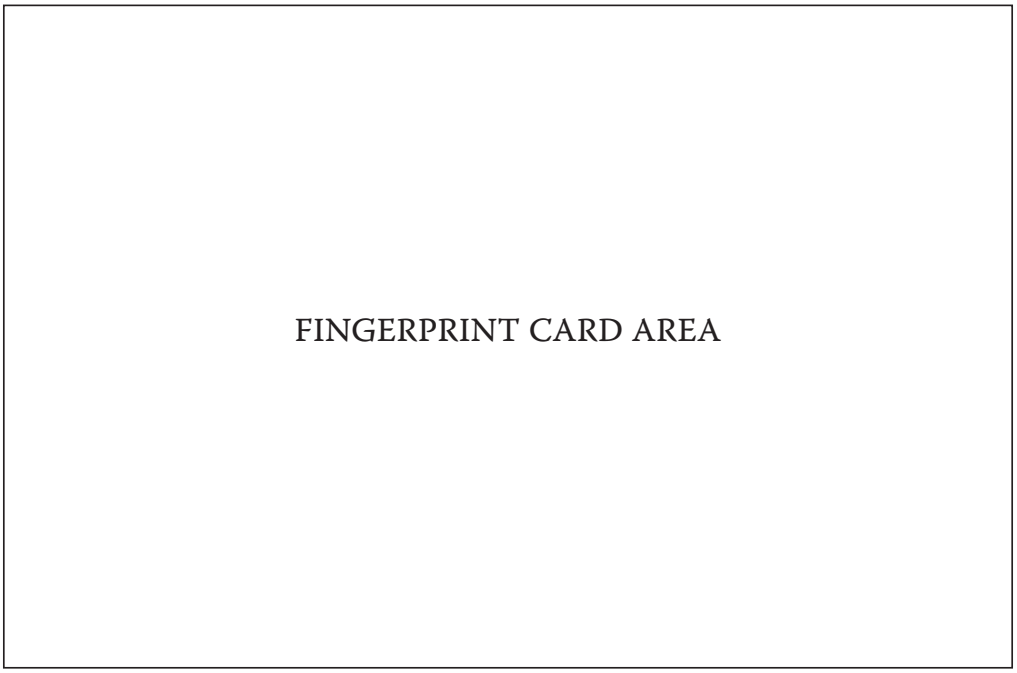


Powder type: Fumed: Yes No
Surface type:
Comments:

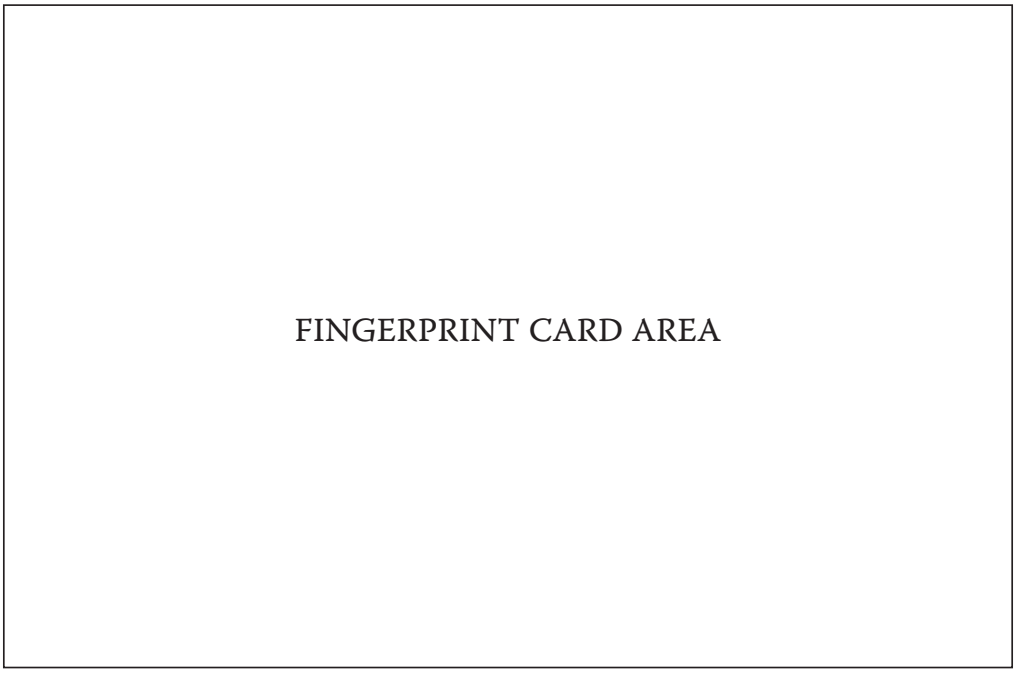


Powder type: Fumed: Yes No
Surface type:
Comments:

CAMEL HAIR BRUSH

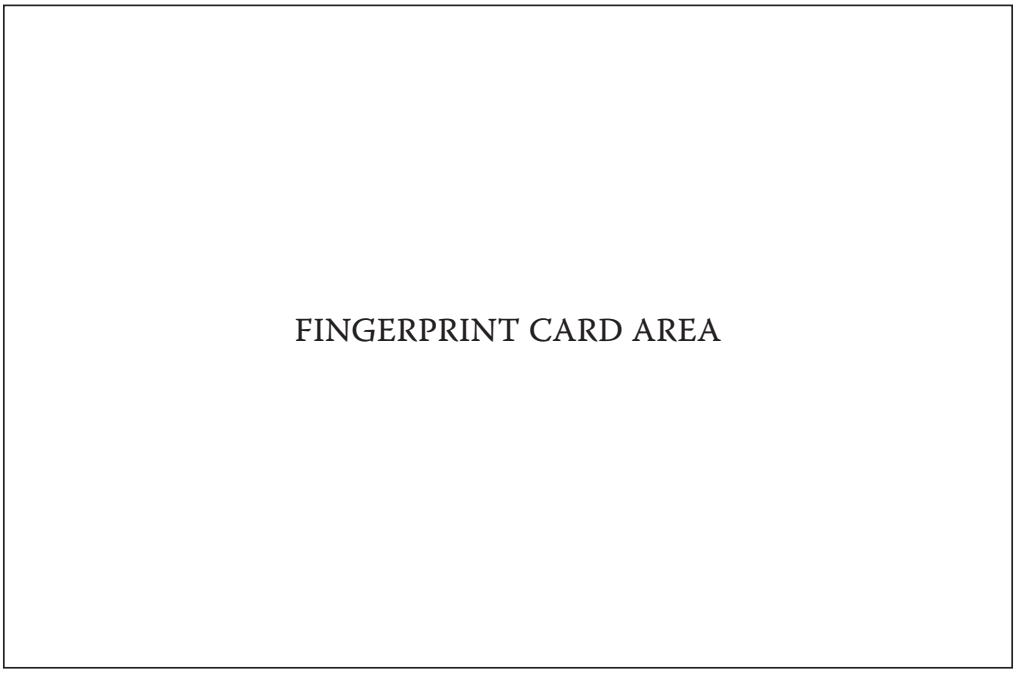


Powder type: Fumed: Yes No
Surface type:
Comments:



Powder type: Fumed: Yes No
Surface type:
Comments:

FEATHER BRUSH



Powder type: Fumed: Yes No
Surface type:
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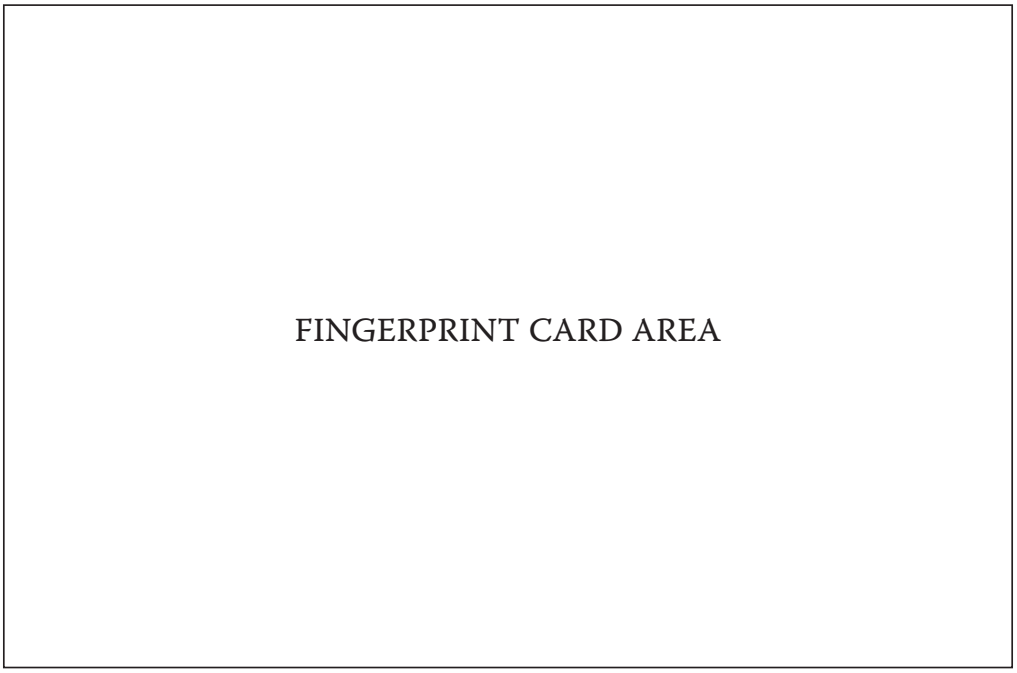
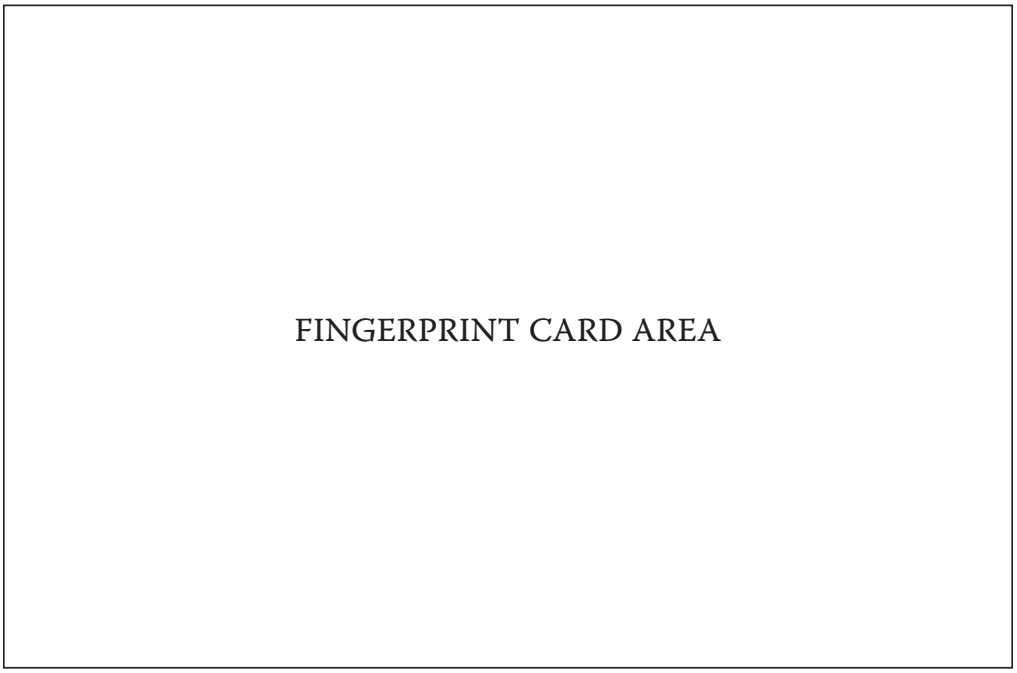


Powder type: Fumed: Yes No
Surface type:
Comments:

FEATHER BRUSH



Powder type: Fumed: Yes No
Surface type:
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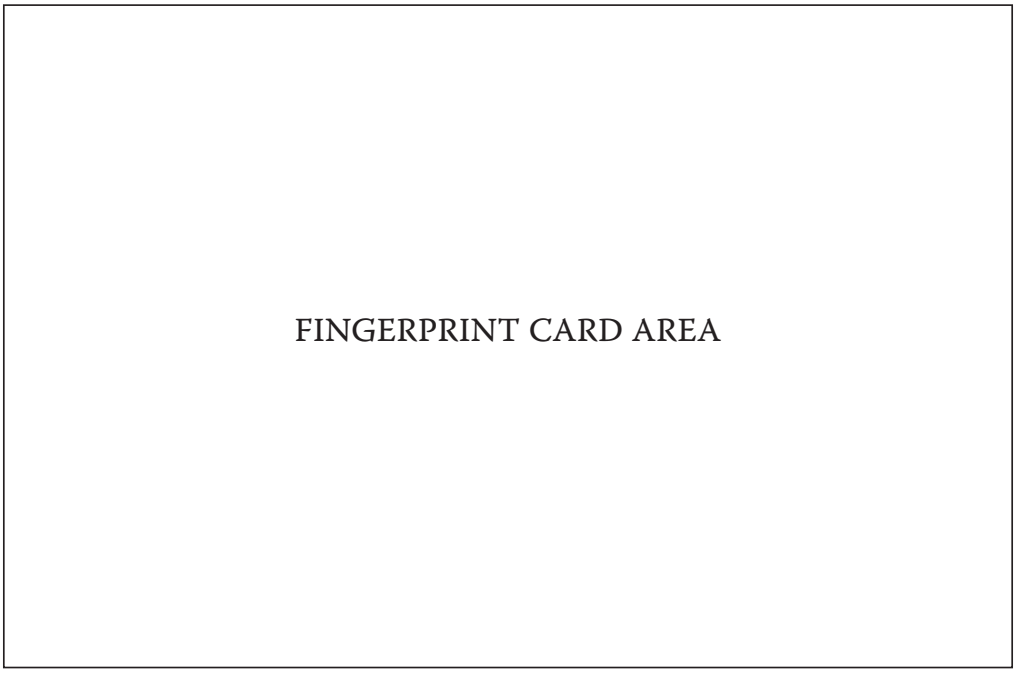


Powder type: Fumed: Yes No
Surface type:
Comments:

Post Lab Questions

1. What is the scientific name for superglue fuming?
2. What is the purpose of superglue fuming?
3. List all items necessary to properly set up and conduct the superglue fuming process.
4. Describe the types of surfaces for which the superglue fuming technique would be used.
5. Describe each type of fingerprint brush used. Discuss the benefits and drawbacks of each type of brush.

10.4 Fluorescent Powder Processing

Objective

- Explain how an alternate light source is used for the development of fingerprints.
- Describe how light is converted to fluorescence.
- Practice developing prints with fluorescent powder.

Concept Overview

Light is a valuable tool in crime scene investigation. Without adequate illumination of a crime scene, an investigation is compromised because evidentiary items will be neither seen nor collected. Nothing rivals clean white light's assistance when searching for and visualizing evidence.

Visible light is radiant energy that we see all around us in the form of colors. However, a very small portion of all the radiant energy represented on the electromagnetic spectrum is visible to the naked eye. Radiant energy travels in waves known as electromagnetic waves, and various forms of radiant energy are characterized by their wavelengths: short, medium, and long. Thus, the electromagnetic spectrum is a continuum on which wavelengths of energy are arranged by length. The electromagnetic spectrum includes gamma rays, x-rays, ultraviolet (UV) energy, visible light, infrared (IR) energy, microwaves, and radio waves (Figure 10.16).

Due to wavelength size, the nanometer (one billionth of a meter) is used to express the wavelength value or the length between the peaks of UV light, visible light, and IR light (Figure 10.17). Interestingly, there is an inverse relationship between wavelength and energy: the shorter the wavelength, the greater the energy; the longer the wavelength, the lower the energy.

Generally, there are four actions that occur, separately or collectively, when light energy strikes and object. Two of those actions are *absorption* and *reflection*. When light energy strikes an object, it does so inclusive of all its primary colors: red, orange, yellow, green, blue, indigo, and violet. The object will absorb, or take in, the majority of the wavelengths striking it and reflect or reemit wavelengths. For example, identifying grass as "green" occurs

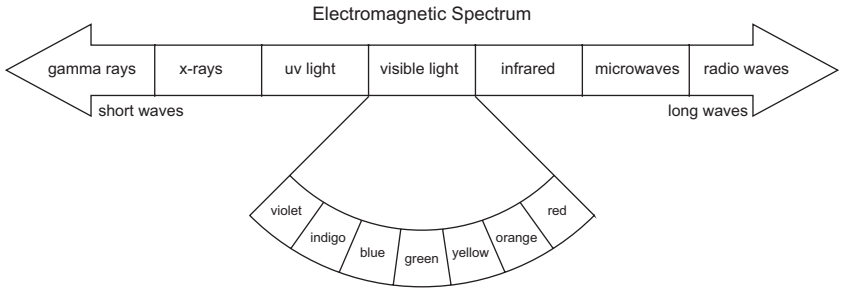


Figure 10.16
Electromagnetic spectrum

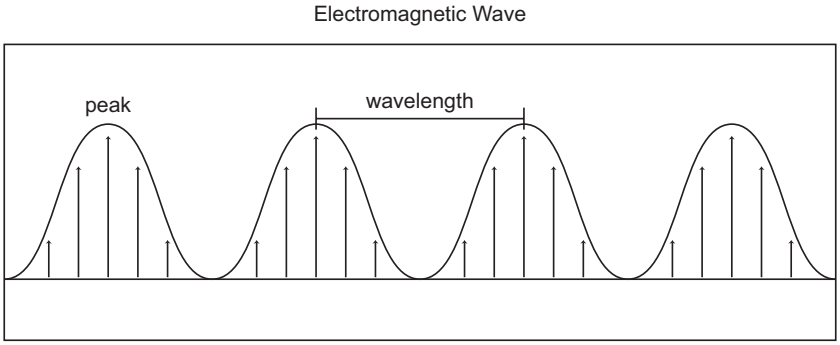


Figure 10.17
Electromagnetic wave.

because the grass has reflected energy wavelengths defined as the color green and absorbed all other wavelengths or colors. When all wavelengths of light are reflected, the color identified is white. When all wavelengths of light are absorbed, the color identified is black. When light can pass through an object, *transmission* is occurring. For example, transmission of a particular wavelength or color can be observed through transparent objects such as water and glass. *Conversion* occurs when a wavelength is changed to another wavelength of different length. For example, luminescence is the ability to emit light without an origin of heat. Luminescence is a broad term that includes phosphorescence and fluorescence. Phosphorescence occurs when an object is stimulated by light, retains the received radiation, and after removal of the stimulation, continues to visibly glow or give off light in the wavelength in which it was converted. Fluorescence occurs when an object absorbs a stimulating light and converts it to a lower intensity (energy) and longer wavelength than that of the illuminating source. The resulting fluorescent light will differ in color from the stimulating light and emit a glowing appearance only during stimulation.

Fluorescence is a valuable tool in the development of friction ridge impressions. Fluorescent powders and dye stains are routinely used to process substrates for the development of these types of impressions. Specific equipment is needed to properly process substrates through fluorescence. An alternate light source (ALS) is a device that allows a specific wavelength of radiant energy to be emitted and used for the examination and processing of substrates. A portion of the emitted energy is reflected by the substrates while some energy is absorbed. The absorbed energy excites the object's electrons into a high energy state. When these electrons return to their original state, energy is emitted that is lower in intensity with a longer wavelength, ergo fluorescence. When employing an ALS, the choice of wavelength is critical, as different objects will absorb light and fluoresce at different wavelengths. Thus, a processor should view a substrate with multiple wavelengths to determine which will allow maximum fluorescence of the substrate and minimum fluorescence of the substrate's background. To view the fluorescence of an object, the processor must wear barrier glasses or use a barrier shield. The use of glasses/shields is imperative, as they block out all wavelengths except that of the resulting fluorescent light. Barrier glasses/shields are of three colors: orange, yellow, and red. The decision as to which color to use is contingent upon the wavelength of light used. There are various combinations of wavelengths and barrier colors. The combination that provides optimal visualization is desirable, and this determination is based on training and experience.

The application of fluorescent powder, conventional and magnetic, is mechanically the same, but different than the application of nonfluorescent powders. However, care needs to be taken with fluorescent powder, as it tends to coat substrates quickly and heavily, thus obscuring developed prints. When using nonmagnetic powder, the feather brush is preferred over the fiber brush, because the feather brush does not acquire as much powder on its bristles and, in turn, applies less powder to a substrate than a fiber brush. When using magnetic powder, the created brush, or bulb of powder, at the end of the wand should barely glide over the substrate to minimize deposition of powder. An advantage to using a magnetic powder and applicator is the ability to clean the wand to prevent contaminating multiple powder colors. When using a fiber or feather brush, the brushes must be dedicated to one specific color to prevent contaminating both the powder and the brush with multiple colors. To properly process an item with fluorescent powder, the processor should be in a dimly lit area and must:

- Wear a set of barrier glasses or look through a barrier filter
- Situate an ALS (or UV light) so that the light emits on the substrate
- Powder the substrate with the barrier and light in place (Figure 10.18)

(As with nonfluorescent powder techniques, substrates may be fumed with cyanoacrylate ester to stabilize the print prior to powdering.)

To document prints developed with fluorescent powder, they must be photographed. The manner in which the print was developed (i.e., the wavelength of light and color barrier filter used) is also the manner in which photographic documentation is to be obtained. Therefore, the components and characteristics used to develop and view the print without the camera are the same ones needed when using the camera to capture the image as the eye sees it (Figure 10.19).

These images are examination-quality photographs, meaning they will be submitted to an expert for examination, analysis, and scientific opinion. For these photographs, macro lenses or diopters (magnification lenses) are used in conjunction with a scale to capture the print in a 1:1 or life-size image. In manual mode, the camera should be set to ISO 100 or 200 with the f/stop ranging from f/8 to f/22, depending on the nature of the substrate containing the print. The shutter speed should be properly adjusted for the lighting conditions of the photography area. Refer to the camera's exposure-level scale. Typically, the indicator should be set to 0 for the initial image and then bracketed photographs taken. However, because fluorescent photography differs from photography using visible light, the exposure-level scale should be set to –2 as a starting point, and photographs should then be bracketed around this value. In addition, the camera should be mounted on a tripod for stabilization, the print should fill the frame, and a cable release cord or the camera's timer should be used to prevent camera shake/blur. Prior to capturing the image, the camera lens *must* be perpendicular or 90 degrees to the print, as this will prevent image distortion. Prints developed with fluorescent powder may also be lifted with clear lifting tape and black lifting cards. Black lifting cards are

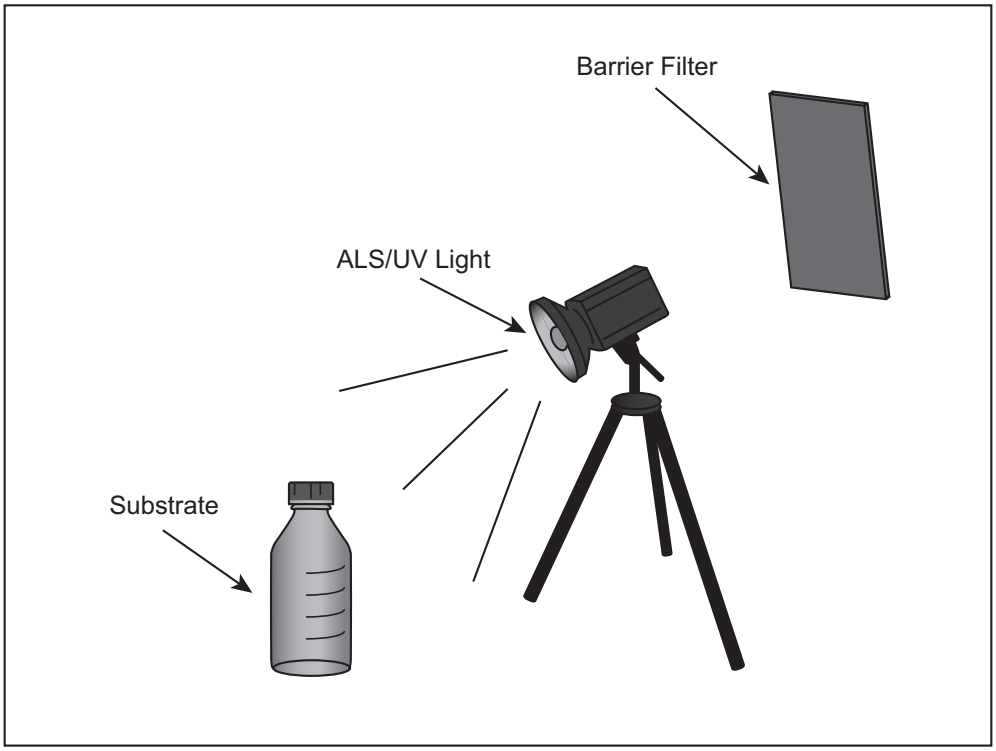


Figure 10.18
Visualizing fluorescent prints.

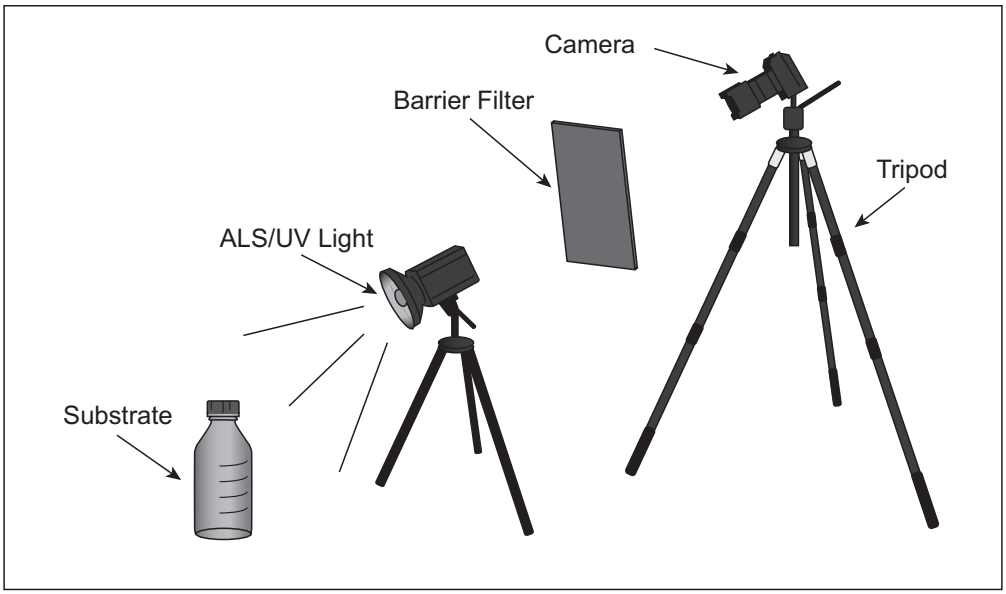


Figure 10.19
Photographing fluorescent prints.

used to create optimal visualization of the lifted colored print. Caution should be exercised after lifting fluorescent prints. It is possible that the lifting card will appear blank or void of a print, but an ALS or UV light and barrier filter/glasses will allow the print to be visualized. This underscores the importance of identifying the lift as a fluorescent powder lift. Without the knowledge of the processing method, the lift card may be considered blank and thus lacking in evidentiary value. The processing method should be part of the following documentation required of all latent lifts:

- Name of processor
- Date/time
- Location from which the print was collected (object/substrate)
- Offense, case number, or title information provided by instructor

A diagram must also be created on the back of the card. The diagram depicts the object that was processed, and an X is placed on the diagram to illustrate the location on the object from which the print was collected. On the front of the card (print side), an arrow is drawn to indicate the orientation of the print.

Materials

- Writing utensil
- Digital camera (SLR preferably), if developed prints are to be photographically documented
- Macro lens (or diopters), if developed prints are to be photographically documented
- Tripod, if developed prints are to be photographically documented

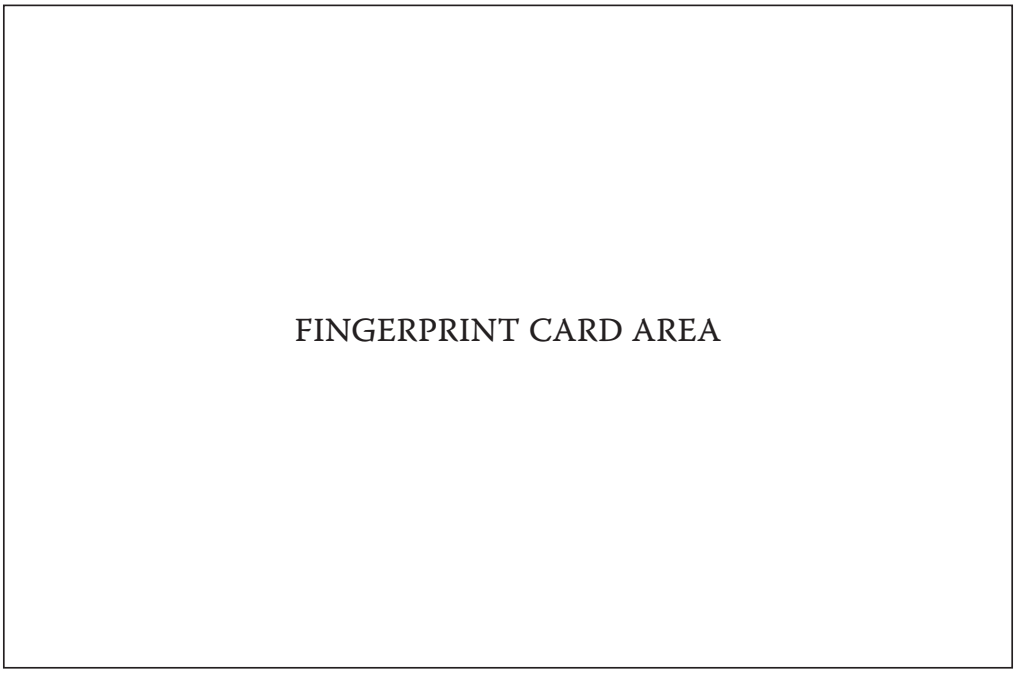
Procedure

1. Each student will create a workstation by covering their work area with butcher paper or other protective covering.
2. Ensure that the following equipment has been gathered and is ready for use:
   - ALS/UV light
   - Barrier filter/glasses
   - Fluorescent powder
   - Powder applicator (appropriate for either conventional or magnetic powder)
   - Lifting cards (black)
   - Clear lifting tape
   - Gloves
3. Ensure that the substrates have latent prints or apply them to the substrates.
4. Put on gloves and barrier glasses and arrange the ALS/UV light so that it emits light on the substrate.
5. Load the applicator with powder and apply it to the substrate. Lightly process to avoid overpowdering.
6. Developed prints should be photographed, if desired by the instructor. The same equipment and settings used to develop the prints will be used to photograph them, including a camera on a tripod. A properly captured image will:
   - Fill the frame
   - Maximize depth of field
   - Include a scale

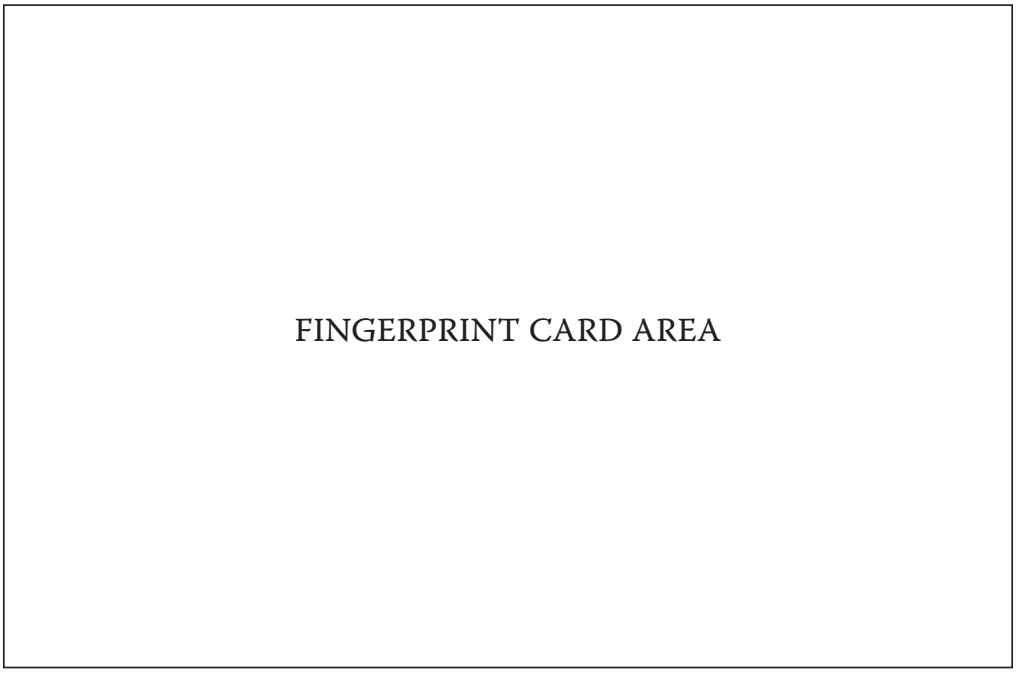
For fluorescent prints, bracketing will ensure an optimal image capture. Viewing the exposure-level scale, capture images at –2, –1, and 0.

7. Lift the developed prints with lifting tape and place on lifting cards. Place proper documentation on the lift card and note that the print was developed with fluorescent powder.
8. Complete Print Processing Worksheet.
9. Complete the Post Lab Questions.

FIBERGLASS BRUSH

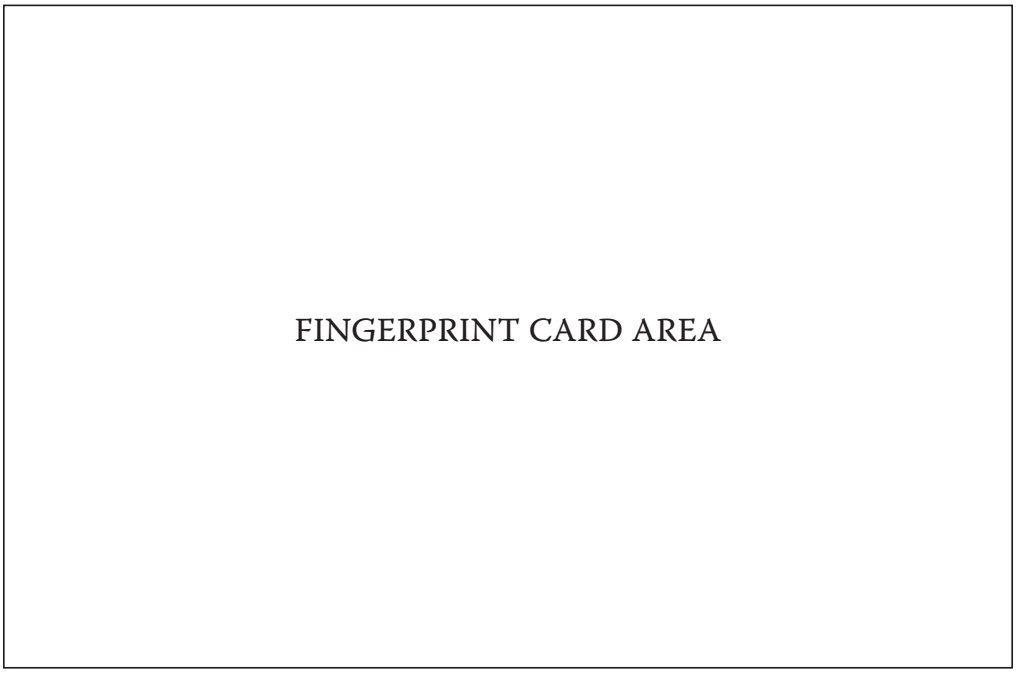


Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

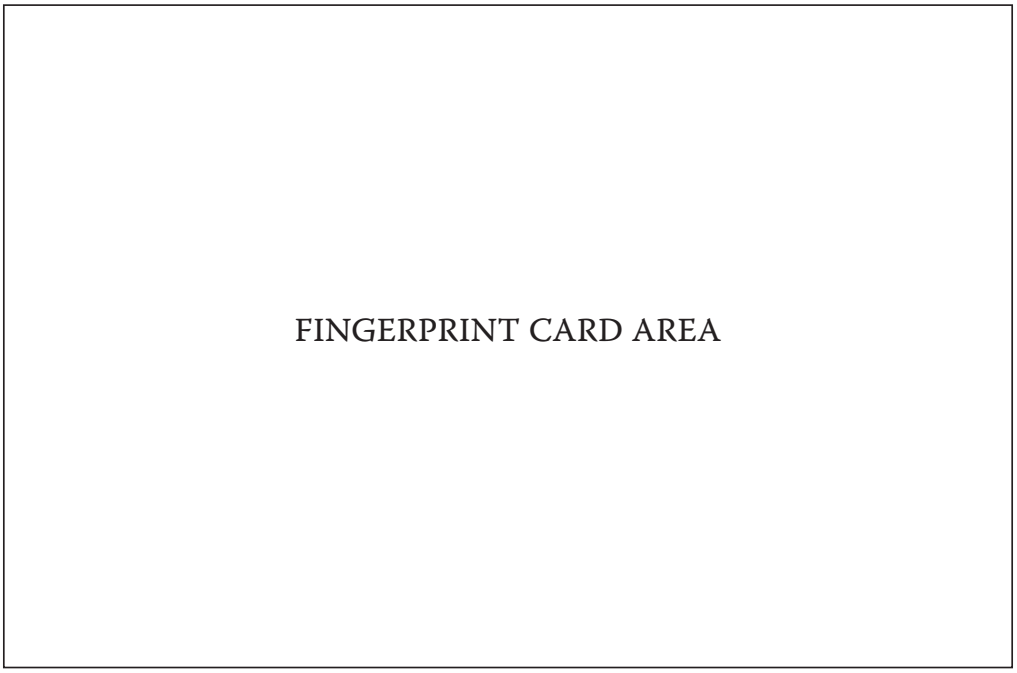


Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

FIBERGLASS BRUSH

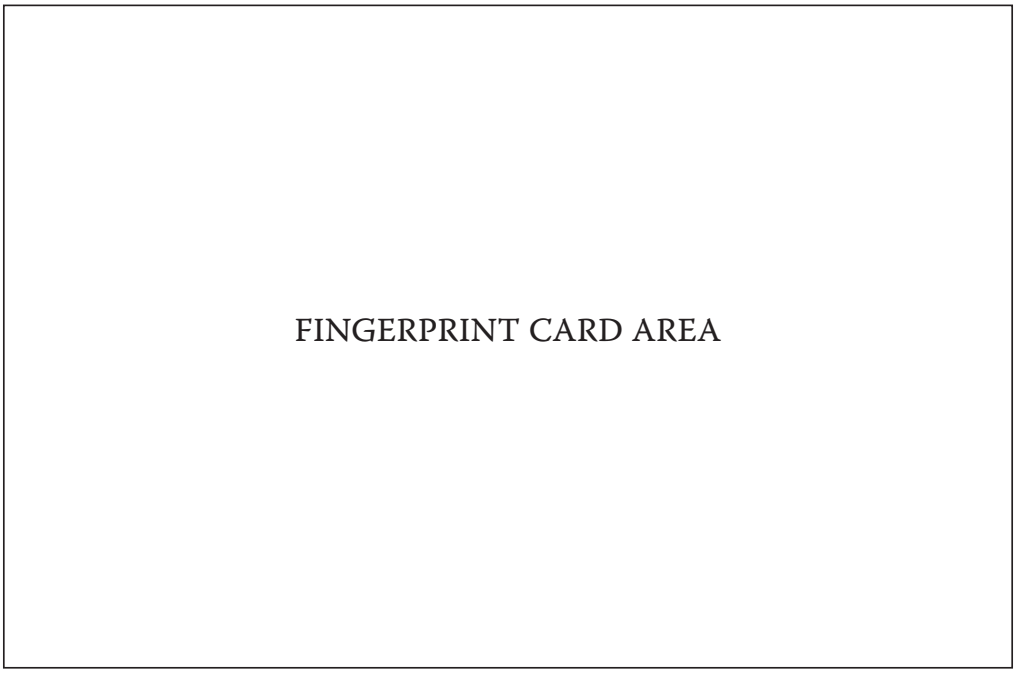


Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

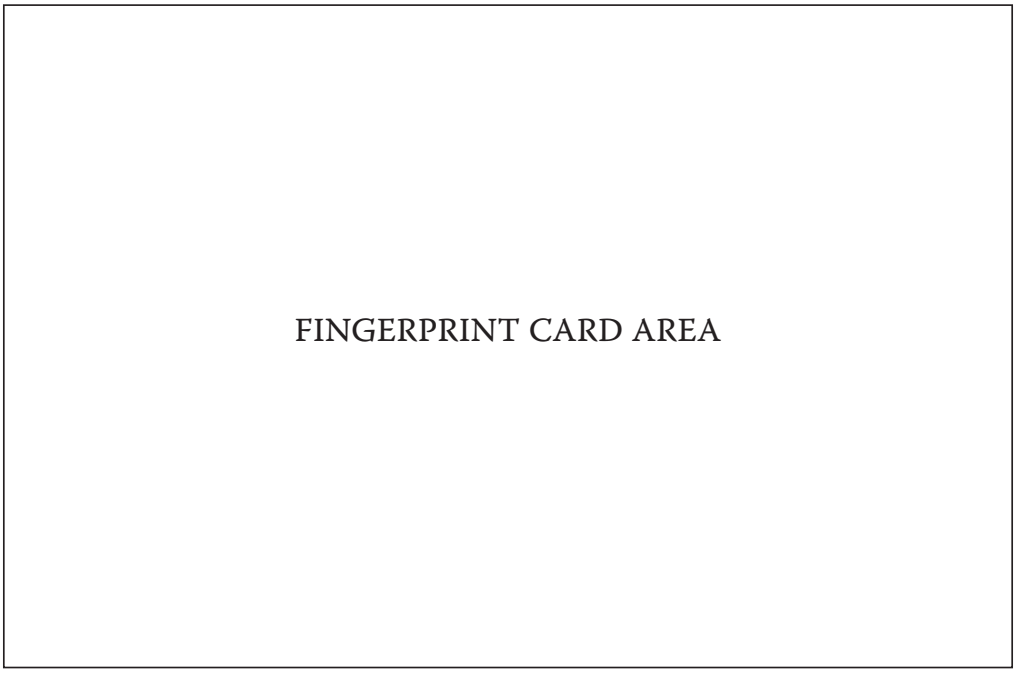


Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

MAGNETIC BRUSH

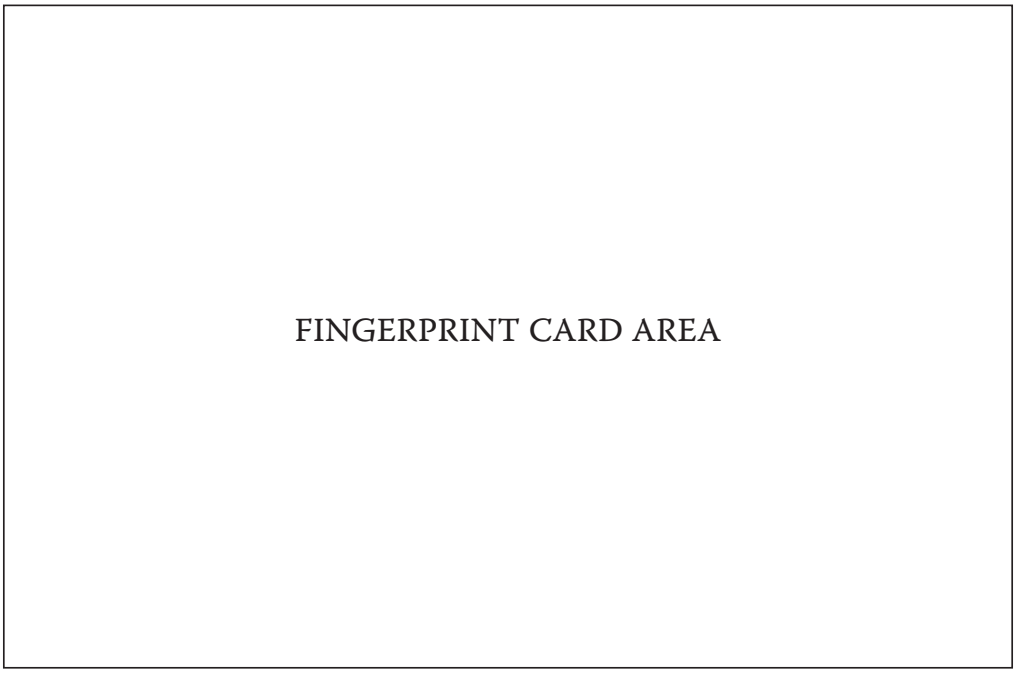


Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

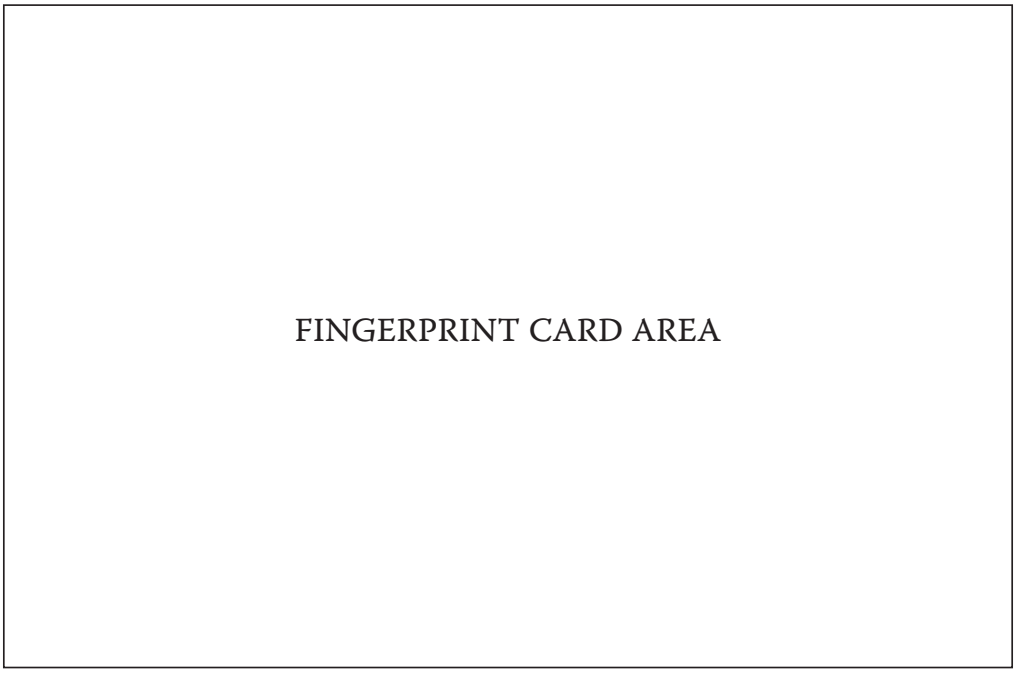


Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

MAGNETIC BRUSH

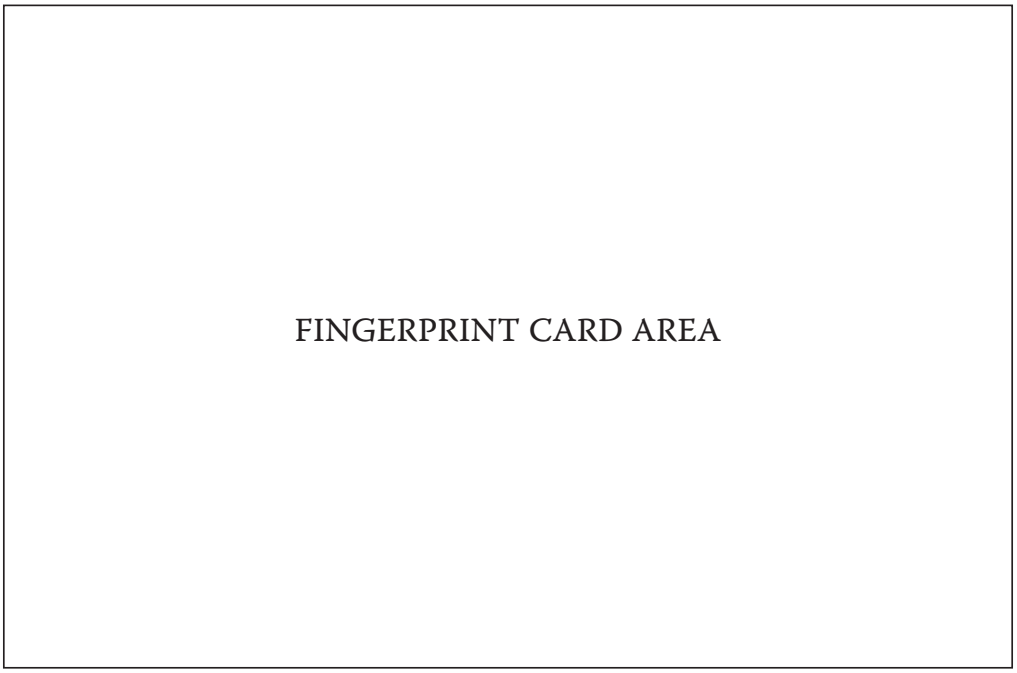


Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

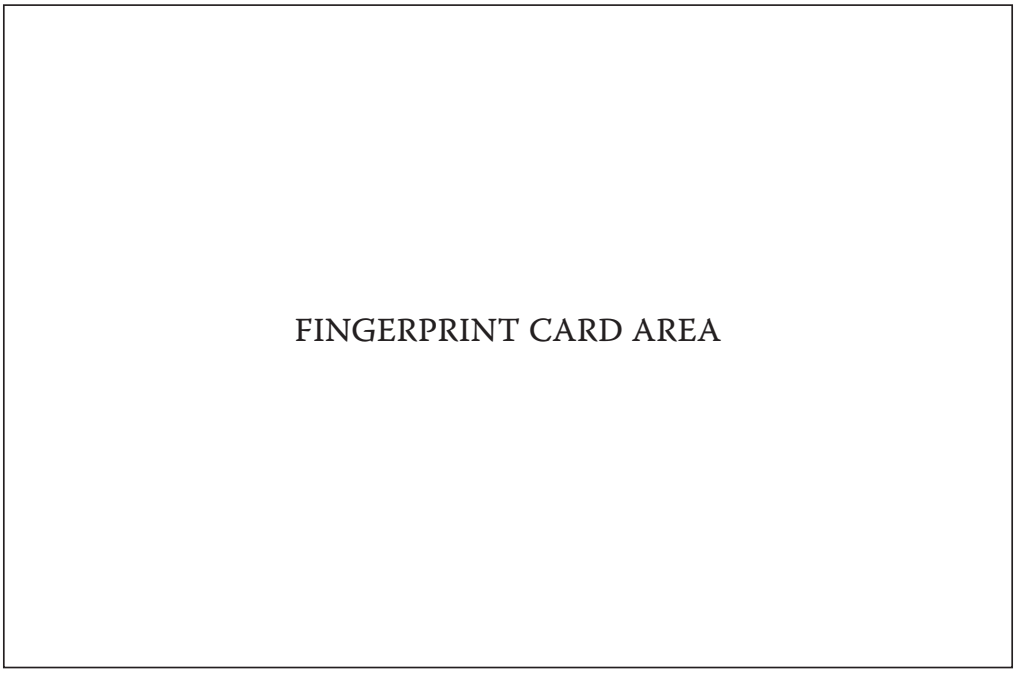


Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

FEATHER BRUSH

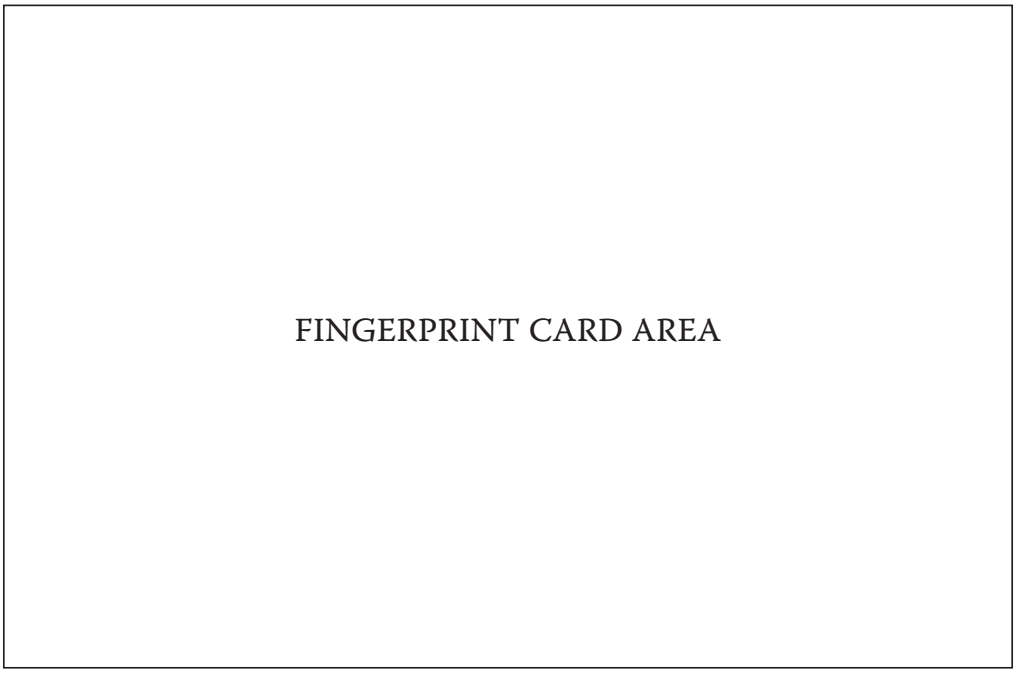


Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

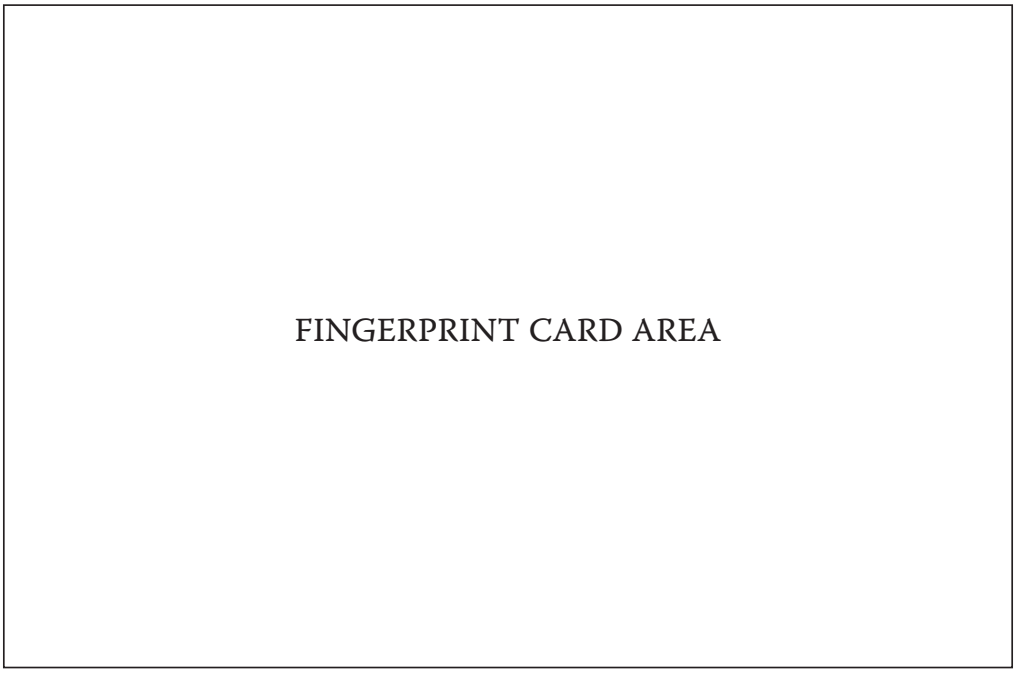


Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

FEATHER BRUSH



Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:



Powder type: Fumed: Yes No
Surface type:
ALS/barrier combination:

Post Lab Questions

1. What are the advantages and disadvantages of the various ALS methods?
2. When should fluorescent powder be used?
3. How is the application of fluorescent powder different than the application of nonfluorescent powder?
4. Why is it important to use a proper combination of filter and barrier?

10.5 Post CA Fuming: Fluorescent Dye Stain Processing (Basic Yellow 40)

Objective

- Explain why CA fuming is important for dye stain processing.
- Explain the procedure for dye stain processing.
- Practice developing prints with dye stain.

Concept Overview

Cyanoacrylate ester fuming (CA fuming), also known as "superglue" fuming, is a technique commonly used to stabilize or harden the print in order for more rigorous processes to be conducted, such as fluorescent dye staining. CA fuming is conducted using an enclosed area such as a fish tank or cardboard box, a heating medium such as a hot plate, a small container of warm water, which produces the humidity needed in the reaction, and a small bottle of liquid superglue. Once the item has been placed in the enclosed area, superglue is placed on the heating element and a chemical reaction takes place. This reaction causes the polymerization of the fingerprint, which allows it to become hardened and stable for further processing. Caution should be used to avoid inhaling CA fumes. Therefore, before removing items from the tank, vent it by slightly canting the tank lid to allow the fumes to escape. After removing objects from the tank's interior, turn the heating element off.

Fluorescent dye staining is a post CA process. It is the CA to which the dye stain adheres. Without the CA on the substrate, the dye stain would simply wash over and off of it. Thus, it is imperative to understand how to CA fume properly for this effort to be successful.

Aside from requiring CA fuming, fluorescent dye staining requires much more specialized equipment than traditional print development methods such as powder/brush. The application of dye stain should be done in a fume hood while wearing protective equipment such as gloves, chemical glasses, and a chemical apron. Gloves should be worn at all times while handling the dye stain and the stained substrates. Tweezers should be used when possible to manipulate the substrates. The advantage of the dye stain process is that it is very effective on multicolor backgrounds, and it is a frictionless development process as opposed to the powder/brush method.

There are various fluorescent dye stains, and each has its own specific criteria for application and visualization in terms of wavelength parameters and barrier filter colors. It is important to be familiar with the specific application and visualization protocols for the chosen dye stain as well as the safety guidelines. For each powder, compound, and chemical reagent available for forensic processing, there is safety information available in the form of a material safety data sheet (MSDS). This information should be available from the vendor or manufacturer and can be located via an Internet search.

In regard to preservation of prints developed with fluorescent dye stains, it must be noted that there is no lifting of these prints. Preservation is through photographic documentation. The photography is the same as that for prints developed with fluorescent powder: the manner in which the print is visualized (i.e., the wavelength of light and color barrier filter used) is also the manner in which photographic documentation is to be obtained. These images are to be examination-quality photographs, meaning they will be submitted to an expert for examination, analysis, and scientific opinion. For these photographs, macro lenses or diopters (magnification lenses) are used in conjunction with a

scale to capture the print in a 1:1 or life-size image. In manual mode, the camera should be set to ISO 100 or 200 with the f/stop ranging from f/8 to f/22, depending on the nature of the substrate containing the print. The shutter speed should be properly adjusted for the lighting conditions of the photography area. Refer to the camera's exposure-level scale. Typically, the indicator should be set to 0 for the initial image and then bracketed photographs taken. However, because fluorescent photography differs from photography using visible light, the exposure-level scale should be set to –2 as a starting point, and photographs should then be bracketed around this value. In addition, the camera should be mounted on a tripod for stabilization, the print should fill the frame, and a cable release cord or the camera's timer should be used to prevent camera shake/blur. Prior to capturing the image, the camera lens *must* be perpendicular or 90 degrees to the print, as this will prevent image distortion.

Materials

- Writing utensil
- Digital camera, if developed prints are to be photographically documented
- Color lens filter or colored barrier shield (yellow and/or orange)
- Shutter-release cable (if camera does not have an internal timer)
- Fluorescent scale of reference, if developed prints are to be photographically documented
- CA fumed substrate
- Basic Yellow 40
- Squeeze bottles (2)
- Catch pans (2)
- Lab tray
- Chemical bench mat
- Chemical glasses
- Chemical apron
- Wax paper
- Tweezers
- Gloves
- Butcher paper
- Watch/time clock
- Alternate light source (415–485 nm) or UV light
- Barrier filter glasses (yellow and/or orange) or UV glasses

Procedure

1. Prep the interior of a fume hood. Line the bottom of the hood with butcher paper, and place chemical bench mats on top of it. On the bench mats, place two catch pans and two squeeze bottles, one with Basic Yellow 40 and the other with water.
2. Each student is to create a workstation by covering their work area with butcher paper and a chemical bench mat.
3. Safety equipment should be donned: gloves, chemical apron, and chemical glasses.
4. Ensure that the following equipment has been gathered and is ready for use:
    - Alternate light source (415–485 nm) or UV light
    - Barrier filter glasses (yellow and/or orange) or UV glasses
    - CA fumed substrate
    - Tweezers
    - Wax paper
    - Lab tray

5. Each student or lab group is to set up a lab tray so that a sheet of wax paper covers the tray top. (The substrate, before and after dye staining, should remain on the wax paper–covered tray at all times.)
6. Each student or lab group should be provided with a CA processed item.
7. Process the item in the fume hood with Basic Yellow 40:
   - With a squeeze bottle, apply the dye stain gently onto the substrate.
   - Let the dye stain remain on the substrate for 1 minute.
   - Rinse the dye stain with the squeeze bottle of water.
   - Take the substrate to your workstation for assessment.
8. Don the barrier filter glasses and use the ALS or UV light to visualize the developed print.
9. Photograph the developed print(s), if desired by the instructor. The equipment needed is:
   - Digital camera
   - Color lens filter or colored barrier shield (yellow and/or orange)
   - Shutter-release cable (if camera does not have an internal timer)
   - Fluorescent scale of reference
   - Alternate light source (415–485 nm) or UV light

   The same equipment and settings used to visualize the prints will be used to photograph them. A properly captured image will:
   - Fill the frame
   - Maximize depth of field
   - Include a fluorescent scale

   For fluorescent prints, bracketing will ensure an optimal image capture. Viewing the exposure-level scale, capture images at –2, –1, and 0.
10. Complete Print Processing Worksheet.

Post Lab Questions

1. What is CA fuming?
2. What is an MSDS sheet?
3. When thinking about the application of dye stains, what considerations should be taken?
4. How are prints developed with dye stains preserved?

10.6 Fingerprint Development on Adhesive Tape: Crystal Violet

Objective

- Understand the development reaction of crystal violet.
- Develop good techniques for processing adhesive tape with crystal violet.
- Practice developing prints on adhesive tape with crystal violet.

Concept Overview

Crystal violet, also referred to as gentian violet, reacts to sebaceous lipids commonly found in epithelial cells by staining the area a deep purple color. Crystal violet works best on fresh prints. Substrates utilized should be nonporous or adhesive, as porous items will absorb the dye stain with no visualization of prints. Crystal violet is easily created

by dissolving crystal violet powder in a liquid solution. Prints developed via this method are documented through photography.

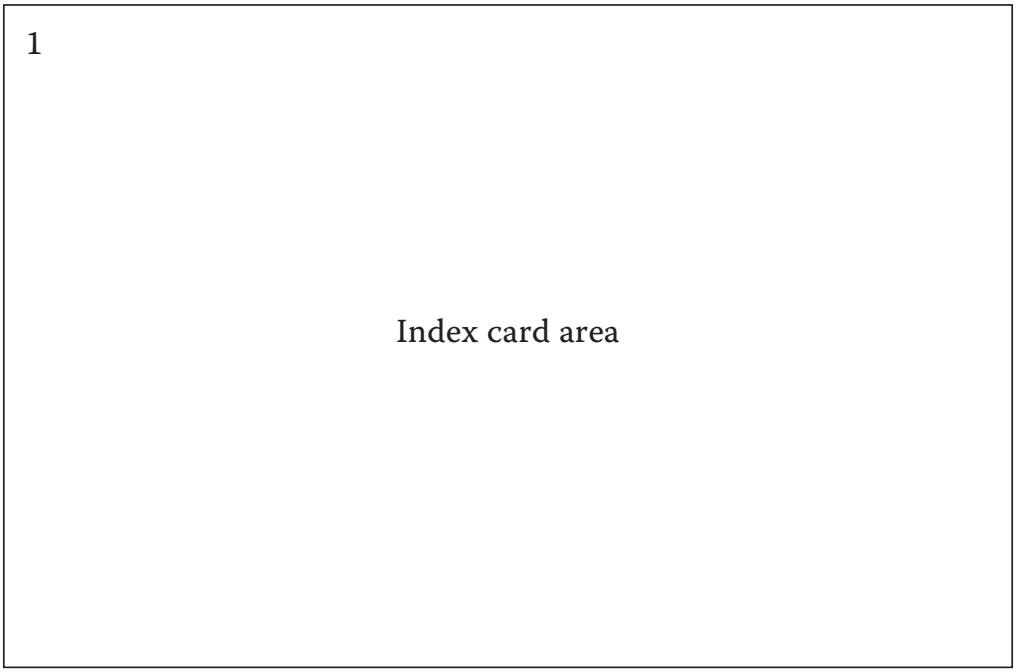
Materials

- Writing utensil
- Digital camera, if developed prints are to be photographically documented
- Scale of reference, if developed prints are to be photographically documented

Procedure

1. Each student will create a workstation by covering their work area with butcher paper or other protective covering.
2. Using scissors, cut pieces of provided tape approximately 1½–2 inches long. Lay these pieces, adhesive side up, on wax paper at your workstation.
3. On each piece of tape, apply fingerprints to the adhesive side and fold a small piece of the tape over onto itself to create a tab. (The tab will be used when moving the tape with tweezers.)
4. Use a fuming tank to fume the tape with cyanoacrylate ester (at the instructor's discretion).
5. Before processing tape with crystal violet, put on:
   - Gloves
   - Chemical glasses
   - Apron or clothing protection
6. Ensure that your workstation has the following before proceeding:
   - Tweezers
   - Glass or plastic bowl containing enough crystal violet to submerge a piece of tape
   - Glass or plastic bowl for capturing runoff water during rinsing of the substrate
   - Squeeze bottle containing tap water
   - Wax paper (to lay processed tape on)
   - Precut pieces of adhesive tape (with latent prints on adhesive side and a small folded tab for maneuvering with tweezers)
7. Use tweezers to place a piece of precut adhesive tape in the container of crystal violet.
8. Keep the tape submerged for 30 seconds to 1 minute.
9. Remove the tape with the tweezers and hold the tape over a second container. Using a squeeze bottle of tap water, rinse the reagent from the tape.
10. Examine the tape for developed prints. If no prints were developed, repeat the processing procedure. If prints were developed but are faint, repeat the processing procedure. Processing may be repeated until the desired contrast is achieved.
11. When the desired contrast is achieved, lay the tape, adhesive side up, on the wax paper for drying. Continue processing with subsequent pieces and types of tape.
12. Document the developed prints with photography (if desired by the instructor). A properly captured image will:
    - Fill the frame
    - Maximize depth of field
    - Include a scale
13. Preserve the developed prints by placing the *dry* tape, adhesive side up, on an index card. Anchor a piece of clear fingerprint tape on the index card approximately ¼ inch from one of the long sides of the tape. Use your finger to smooth the tape over the developed print and cut the tape. The index card should now preserve the tape and its developed print. Attach the index card to the Print Processing Worksheet and complete the worksheet.
14. Complete the Post Lab Questions.

Crystal Violet		
Tape Type	Fumed: Yes/No	Notes
1		
2		
3		
4		



2

Index card area

3

Index card area

4

Index card area

Post Lab Questions

1. Were the prints easy to develop?
2. In reviewing the prints developed, how many prints are visible?
3. What are some challenges encountered when processing with crystal violet?

10.7 Fingerprint Development on Adhesive Tape: Sticky Side Powder

Objective

- Understand the development reaction of Sticky Side Powder.
- Develop good techniques for processing adhesive tape with Sticky Side Powder.
- Practice developing prints on adhesive tape with Sticky Side Powder.

Concept Overview

Sticky Side Powder is a silver, metallic-like substance that is combined with detergent and water to create a paste. It reacts to the sebaceous and lipid components of fingerprint deposits through the development of gray/silver-colored prints. Substrates utilized should be nonporous, as porous items will absorb the reagent with no visualization of prints. Prints developed via this method are documented through photography.

Materials

- Writing utensil
- Digital camera, if developed prints are to be photographically documented
- Scale of reference, if developed prints are to be photographically documented

Procedure

1. Each student will create a workstation by covering their work area with butcher paper or other protective covering.
2. Using scissors, cut pieces of provided tape approximately 1½–2 inches long. Lay these pieces, adhesive side up, on wax paper at your workstation.
3. On each piece of tape, apply fingerprints to the adhesive side and fold a small piece of the tape over onto itself to create a tab. (The tab will be used when moving the tape with tweezers.)
4. Before processing tape with Sticky Side Powder, put on:
   - Gloves
   - Apron or clothing protection
5. Ensure that your workstation has the following before proceeding:
   - Tweezers
   - Glass or plastic bowl containing Sticky Side Powder reagent
   - Camel hair brush
   - Glass or plastic bowl for capturing runoff water during rinsing of the substrate
   - Squeeze bottle containing tap water
   - Wax paper (to process tape on and lay processed tape on)
   - Precut pieces of adhesive tape (with latent prints on the adhesive side and a small folded tab for maneuvering with tweezers)
6. Use tweezers to place a piece of precut adhesive tape on the wax paper.
7. Use the camel hair brush to "paint" the reagent onto the adhesive side of the tape. Allow the reagent to remain on the tape for 30–60 seconds.
8. Use the tweezers to hold the tape over a second container. Using a squeeze bottle of tap water, rinse the reagent from the tape.
9. Examine the tape for developed prints. If no prints were developed, repeat the processing procedure. If prints were developed but are faint, repeat the processing procedure. Processing may be repeated until the desired contrast is achieved.
10. When the desired contrast is achieved, lay the tape, adhesive side up, on the wax paper for drying. Continue processing with subsequent pieces and types of tape.
11. Document the developed prints with photography (if desired by the instructor). A properly captured image will:
    - Fill the frame
    - Maximize depth of field
    - Include a scale
12. Preserve the developed prints by placing the *dry* tape, adhesive side up, on an index card. Anchor a piece of clear fingerprint tape on the index card approximately ¼ inch from one of the long sides of the tape. Use your finger to smooth the tape over the developed print and cut the tape. The index card should now preserve the tape and its developed print. Attach the index card to the Print Processing Worksheet and complete the worksheet.
13. Complete the Post Lab Questions.

Sticky Side Powder	
Tape Type	Notes
1	
2	
3	
4	

1

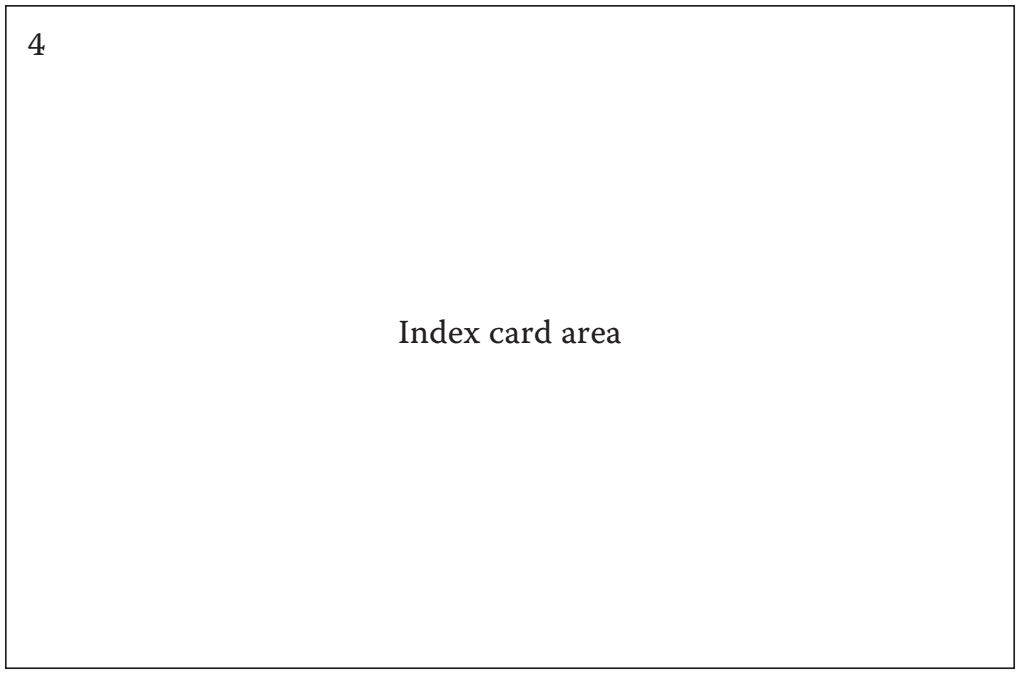
Index card area

2

Index card area

3

Index card area



Post Lab Questions

1. Were the prints easy to develop?
2. In reviewing the prints developed, how many prints are visible?
3. What are some challenges encountered when processing with Sticky Side Powder?
4. Compare and contrast crystal violet and Sticky Side Powder.

10.8 Fingerprint Development on Absorbent Substrates: Iodine

Objective

- Understand the development reaction of iodine.
- Develop good techniques for processing absorbent substrates with iodine.
- Practice developing prints on absorbent substrates with iodine.

Concept Overview

Iodine reacts to the fatty and oily components of fingerprint deposits. Developed fingerprints are yellow/brown in color. Substrates processed may be porous or nonporous. Iodine is typically used on paper items, especially thermal paper, and can even develop prints on both sides of the thermal paper, unlike ninhydrin, which will cause thermal paper to turn black and obscure developed prints. Iodine works best on fresh prints. While this method is effective, it is important to note that iodine-developed prints fade rapidly. Documentation of developed prints, through photography, must be done quickly to ensure that the maximum print quality is being recorded and preserved.

Additionally, if desired, iodine may be used in sequential processing and is the first processing method used, followed by ninhydrin.

It is important to note that a number of safety risks are involved with this method. Caution should be taken, especially when using iodine fuming tubes in which the processor must blow through the tube to create heat and moisture for the iodine crystals located at the bottom of the tube. Much safer methods of processing include placing iodine crystals in a ziplock bag with the item that needs to be processed, or impregnating a silicon gel pack with iodine fumes and lightly brushing it over the item in question.

Materials

- Writing utensil
- Heating element, such as an iron
- Digital camera, if developed prints are to be photographically documented
- Scale of reference, if developed prints are to be photographically documented

Procedure

1. Each student will create a workstation by covering their work area with butcher paper or other protective covering.
2. Use scissors to cut substrates (paper/cardboard/raw wood) to fit inside fuming baggies.
3. Touch all substrates to deposit fingerprints.
4. Wear the following personal protective equipment (PPE):
   - Gloves
   - Mask
   - Eye protection
   - Apron or clothing protection
5. Ensure that your workstation has the following before proceeding:
   - Tweezers
   - Iodine fuming wand or iodine crystals
   - Plastic, sealable baggie (to contain the crystals and substrates)
   - Absorbent substrates (paper, cardboard, raw wood)
   - Access to a vent hood or well-ventilated area
6. If using a fuming wand, follow the kit instructions and proceed to step 9.
7. If processing with iodine crystals, use tweezers to place absorbent substrates in a baggie containing the crystals.
8. Monitor the development of prints on the substrates. (The baggie should be placed on a covered/protected surface to prevent fume staining. Also, the baggie should be in a vent hood or well-ventilated area during the sublimation of the crystals.)
9. When prints are developed, remove the substrates from the baggie and document them with photography before the prints fade (if desired by the instructor). If fading occurs prior to documentation, the substrate(s) may be processed again. A properly captured image will:
   - Fill the frame
   - Maximize depth of field
   - Include a scale
10. Complete the Post Lab Questions.

Post Lab Questions

1. What surface types are conducive to iodine fuming?
2. Why is it important to wear PPE when processing with iodine?
3. How does iodine differ from other fingerprinting methods?
4. What are the advantages of using iodine fuming?

10.9 Fingerprint Development on Absorbent Surfaces: Ninhydrin

Objective

- Understand the development reaction of ninhydrin.
- Develop good techniques for processing absorbent substrates with ninhydrin.
- Practice developing prints on absorbent substrates with ninhydrin.

Concept Overview

Ninhydrin reacts to the amino acids and proteins of fingerprint deposits through the development of purple-colored prints. Substrates utilized for this process should be porous. This process works best on "old" prints, because the substrate must have time to absorb the deposited amino acids. Over time, the developed prints will fade. Prints developed via this method are documented through photography. The shelf life of this reagent is approximately 12 months. If desired, ninhydrin may be used in sequential processing after the application of iodine.

Ninhydrin may be purchased from forensic vendors as an aerosol or in premixed liquid form that may be heptane based, methanol based, or acetone based. Various application methods may be used based on the item in question. Spraying, immersing, and painting/brushing are all acceptable methods of application.

Materials

- Writing utensil
- Digital camera, if developed prints are to be photographically documented
- Scale of reference, if developed prints are to be photographically documented

Procedure

1. Before processing substrates with ninhydrin, put on:
   - Gloves
   - Mask
2. Use tweezers to hold a substrate that has been prepared with fingerprint deposits.
3. Apply the ninhydrin in a vent hood or well-ventilated area.
4. Allow prints to develop overnight or use an acceleration method.*
5. Examine the substrate for developed prints.

6. Document the developed prints with photography (if desired by the instructor). A properly captured image will:
   - Fill the frame
   - Maximize depth of field
   - Include a scale
7. Complete the Post Lab Questions.

*Steam and heat from an iron may be used as an acceleration method to develop prints quickly. The key to this method is the application of the heat/steam, without allowing the iron to come into contact with the substrate.

Post Lab Questions

1. Compare and contrast the chemical processing methods for developing fingerprints.
2. Which chemical processing method provided more detail?
3. What surface type yielded the best chemically processed prints?
4. Is there one perfect chemical method for fieldwork? Why or why not?

10.10 Print Development with Small Particle Reagent

Objective

- Identify the component of print deposits with which small particle reagent (SPR) reacts.
- Describe the process of developing prints with SPR.
- Practice developing prints with SPR.

Concept Overview

Small particle reagent is micropulverized powder suspended in a solution. It is a liquid fingerprint powder that reacts with the fatty deposits of fingerprint residue. Initially, this reagent was used for the development of prints on wet surfaces. However, field and lab use has demonstrated the reagent's ability to develop prints on a variety of porous and nonporous substrates, such as cardboard, plastic, vinyl, rocks, wood, and glass. It can also be used on substrate surfaces containing contaminate residues that would destroy a fingerprint brush. The developed prints should be documented with photography, followed by lifting with clear lifting tape.

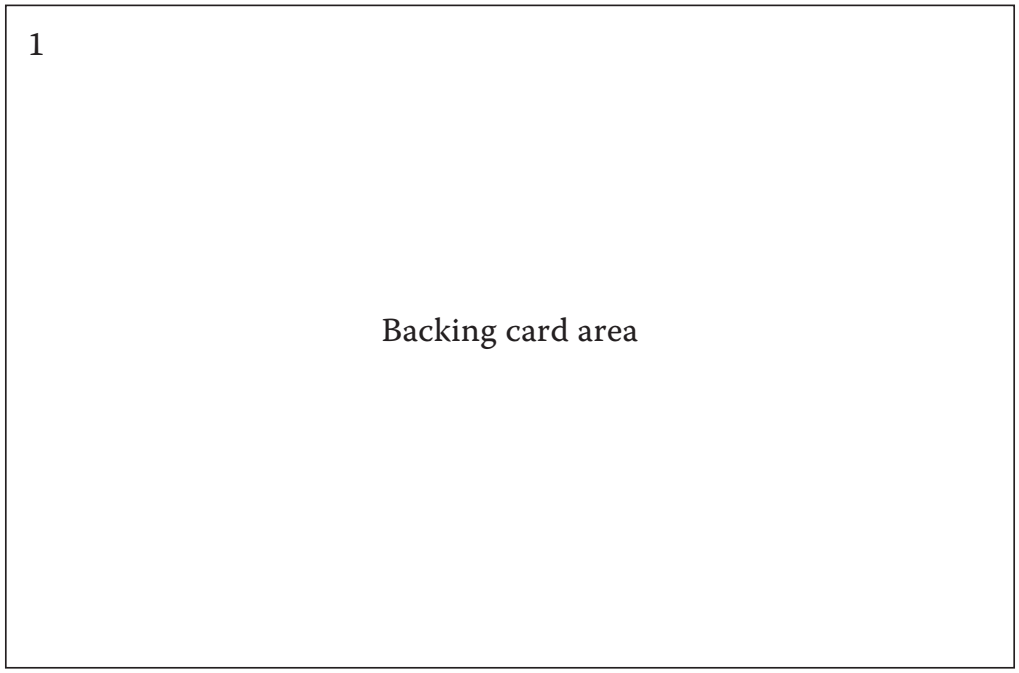
Materials

- Writing utensil
- Digital camera, if developed prints are to be photographically documented
- Scale of reference, if developed prints are to be photographically documented

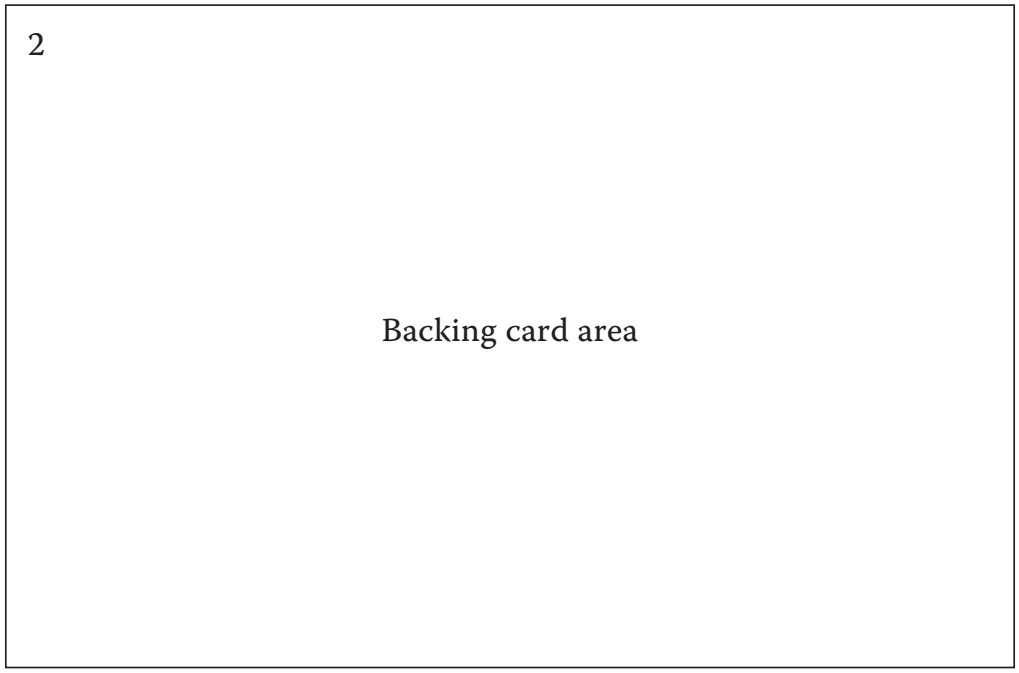
Procedure

1. Each student will create a workstation by covering their work area with butcher paper or other protective covering. This material should also be placed on the floor around your workstation to catch spills and spatter.
2. Confirm that the substrates to be processed have latent prints. If necessary, apply prints to your substrates.
3. Before processing with SPR, put on:
   - Gloves
   - Apron or clothing protection
4. Ensure that your workstation has the following supplies:
   - SPR in a spray bottle (fine-mist setting for adjustable nozzles)
   - Water in a spray bottle
   - Tweezers
   - Pyrex dishes (two as capture containers for SPR and water runoff)
   - Substrates (with latent prints)
5. For applicable substrates, use reflective lighting from the light source at the work area to visualize latent prints on the substrate.
6. For practice developing prints on wet objects, wet the substrate prior to the application of SPR.
7. Hold the substrate, by either hand or tweezers, over a Pyrex dish and spray SPR above the visualized latent prints. Do not spray SPR directly on the print(s); allow the solution to wash over the print(s). If no prints were visualized via reflective lighting, spray SPR at the top of the object to allow the reagent to run down the object.
8. After print development, move the object over a second capture container. Spray water onto the substrate, above the developed prints, to rinse off the SPR. Reapplication is acceptable to achieve desired contrast.
9. Document the developed prints with photography (if desired by the instructor). A properly captured image will:
   - Fill the frame
   - Maximize depth of field
   - Include a scale
10. Preserve the developed print through lifting, which may be done with traditional lifting tape and a backing card after the object has dried. (Allow the object/print to dry naturally; do not apply artificial heat.) A wet lift may also be conducted. This will require clear lifting tape, a rubber squeegee, and a backing card. Ideally, two people should participate in a wet lift, as the tape will not adhere to a wet surface. An assistant is needed to stabilize the object and anchor the tape. From the anchor point, use the squeegee to move across the tape and over the print to push out the water. Then, anchor one end of the tape on a backing card and use the squeegee to apply the tape to the card. (Prints developed on porous surfaces such as paper or cardboard will not be lifted.)
11. Repeat steps 5–10 for all objects provided by the instructor.
12. Attach backing cards to Print Processing Worksheet and complete the worksheet.
13. Complete the Post Lab Questions.

Evaluation Worksheet

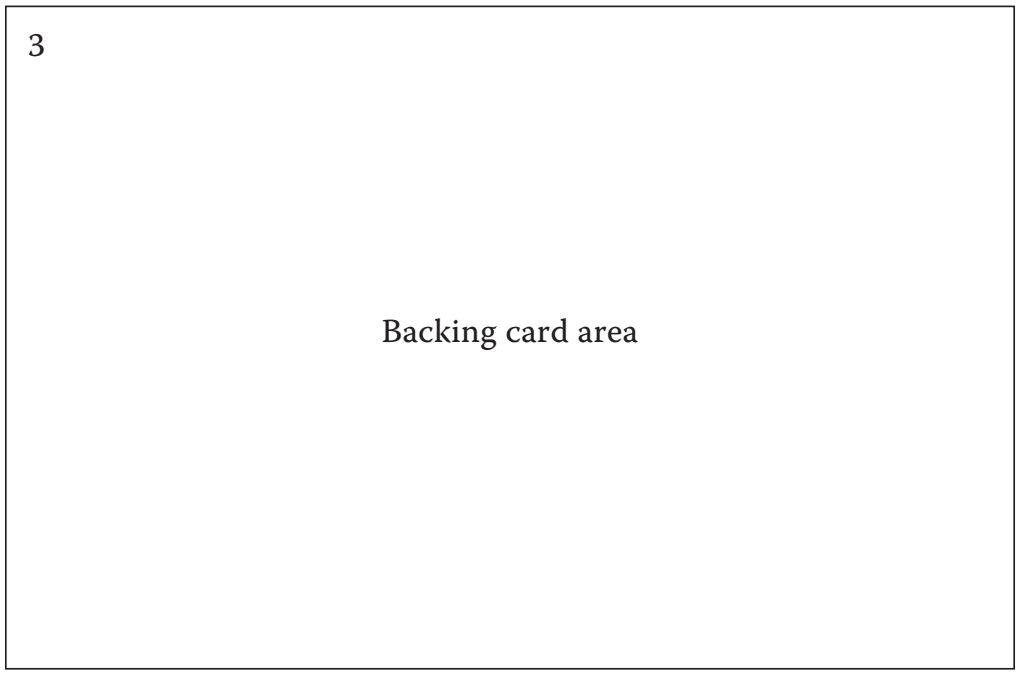


Object: Porous Nonporous
Observations:

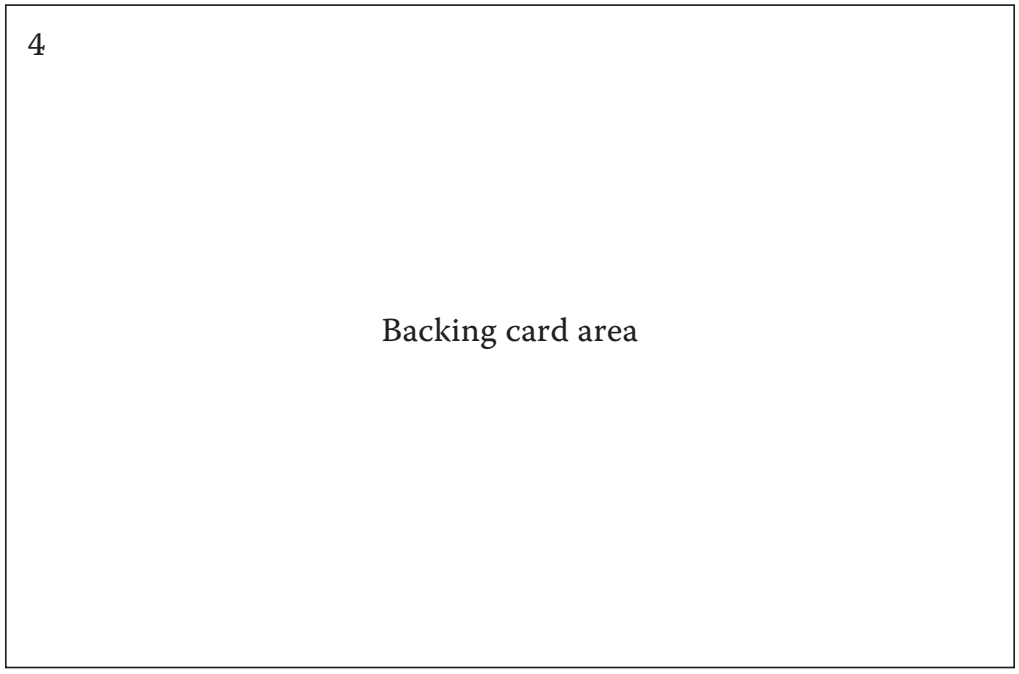


Object: Porous Nonporous
Observations:

Evaluation Worksheet

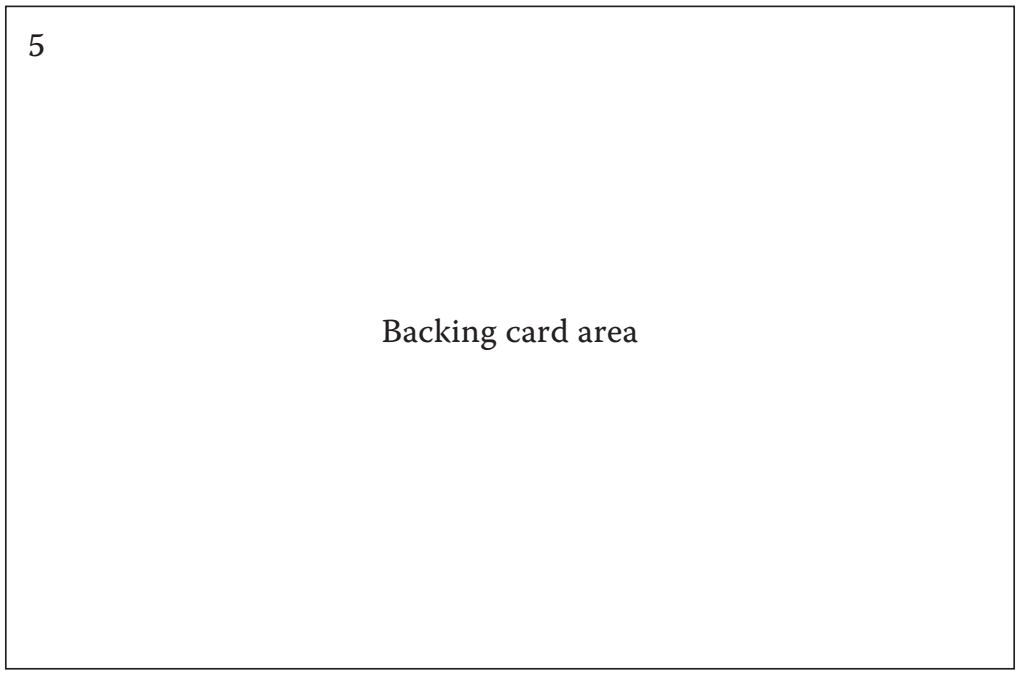


Object: Porous Nonporous
Observations:

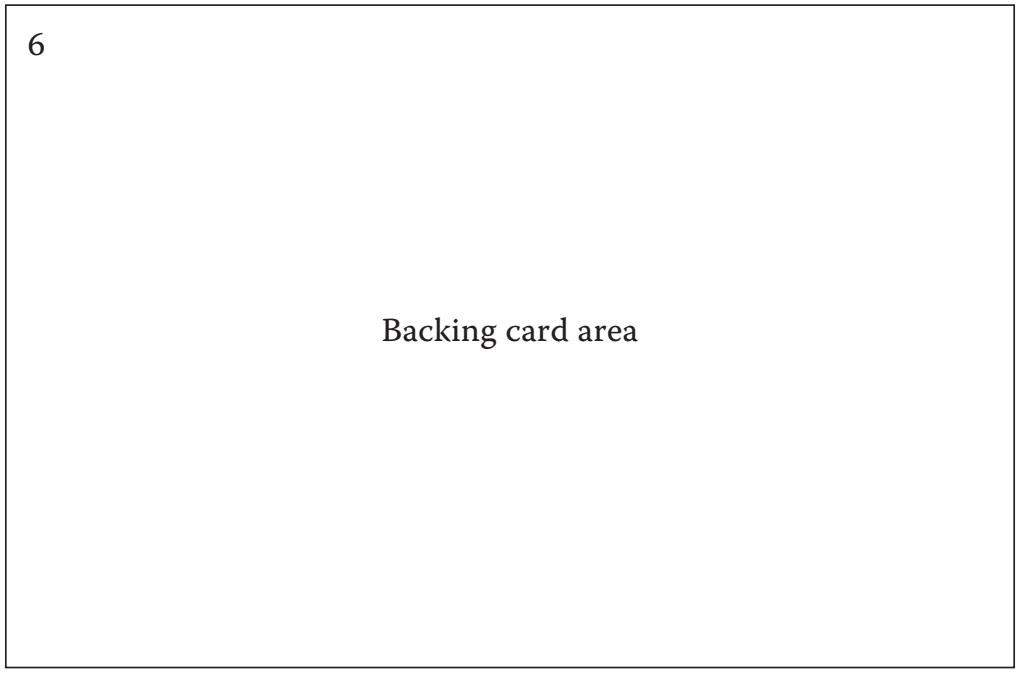


Object: Porous Nonporous
Observations:

Evaluation Worksheet

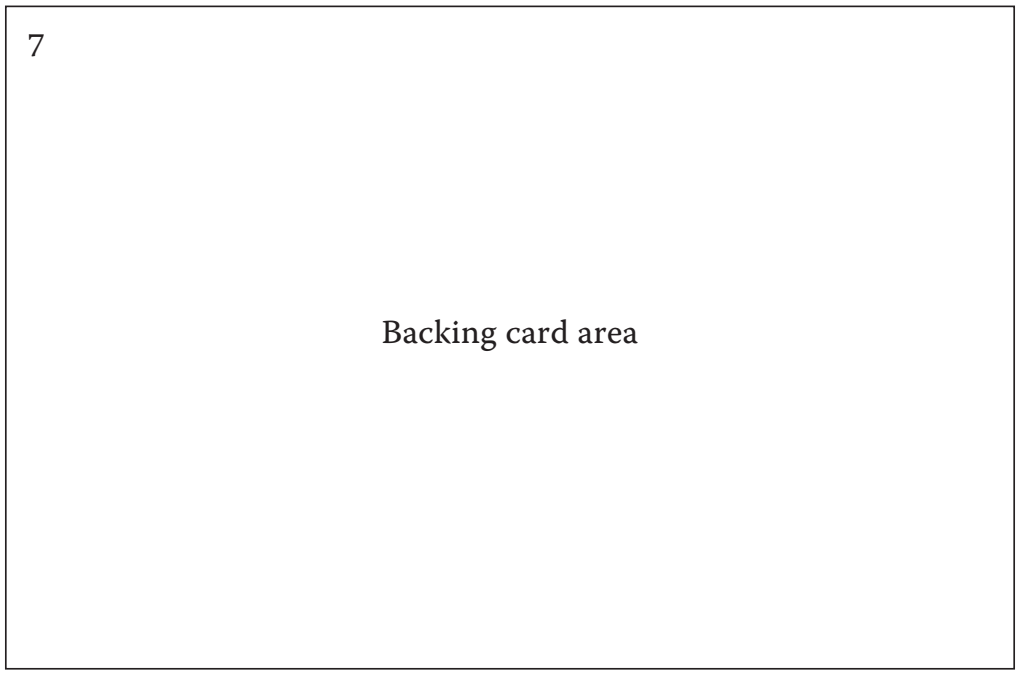


Object: Porous Nonporous
Observations:

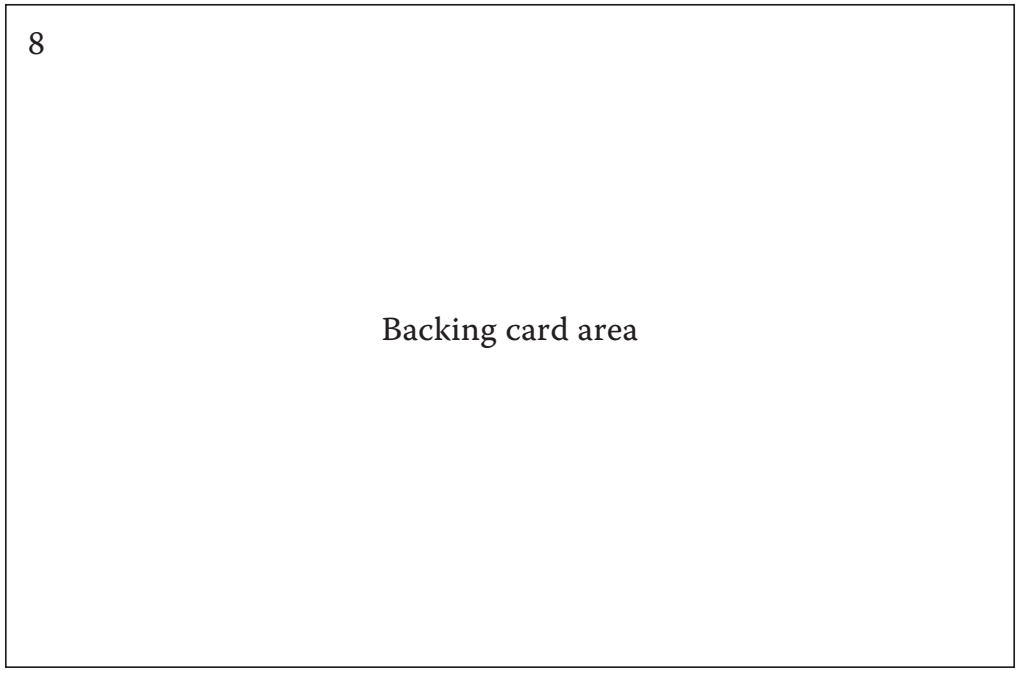


Object: Porous Nonporous
Observations:

Evaluation Worksheet

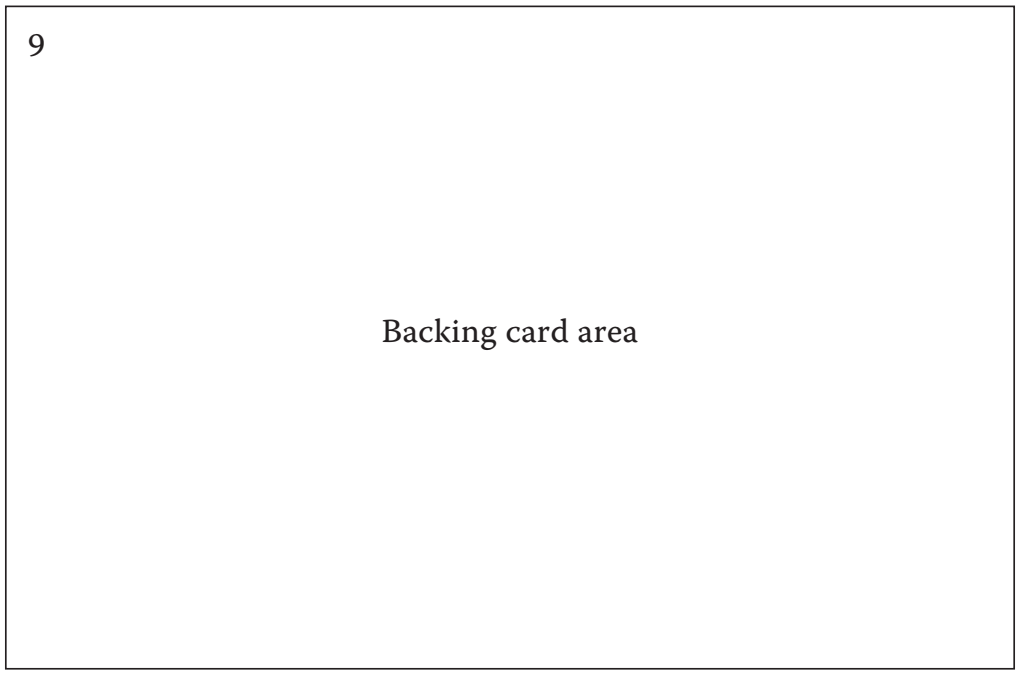


Object: Porous Nonporous
Observations:

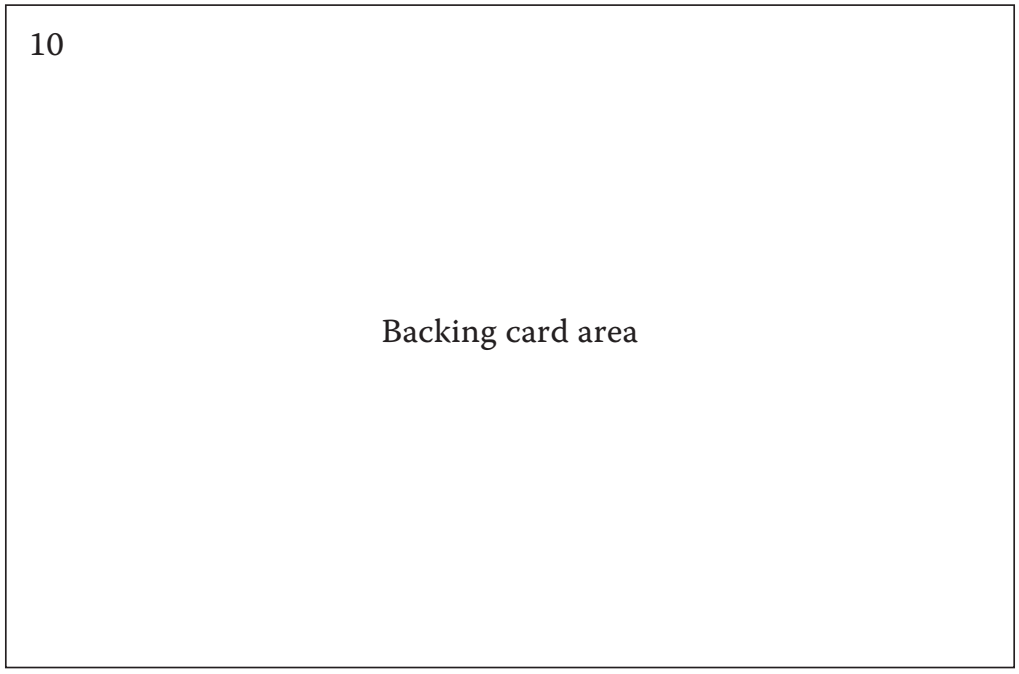


Object: Porous Nonporous
Observations:

Evaluation Worksheet



Object: Porous Nonporous
Observations:



Object: Porous Nonporous
Observations:

Post Lab Questions

1. How many prints were developed using small particle reagent?
2. Based on your data table, which surface was the most successful?
3. What is small particle reagent?

10.11 Recovering Fingerprints from Burned Items

Objective

- Describe the scene conditions that make fire scenes difficult and complex.
- Explain the meaning of the fire tetrahedron.
- Practice recovering fingerprints from burned items.

Concept Overview

Fire scenes are one of the most challenging scenes a crime scene technician may face. It is important for them to understand not only the concept of fire, but also the dangers and trials that may be associated with this type of scene. The fire tetrahedron is the easiest way to remember the necessary conditions for starting a fire. The fire tetrahedron is a representation of the components that must be present for a fire to start, such as a source of heat or energy (i.e., a match), fuel, oxygen, and a chain reaction. The chain reaction begins with a reaction between the fuel and oxygen, which causes the heat that expedites the chemical reaction to the point of ignition. This chemical reaction can happen slowly or quickly, depending on the type of fuel used and its associated ignition temperature.

Fire scenes can be extremely difficult to process. A number of hazards and challenges exist, including structural instability, exposed metal, nails and other dangerous objects, inhalation hazards, and water damage to material at the scene. Inadequate lighting may cause additional difficulties for crime scene personnel who cannot see the crime scene properly.

While many challenges exist, recovering fingerprints is still possible with the employment of the proper methodology. Although burnt items may be black from soot deposition, the process of burning has literally etched the fingerprint(s) into the exterior of the item. The challenge is to remove the soot in order to expose the fingerprint.

The first step in the process is visual examination. The processor must have access to clean white light for a proper examination. The item is manipulated by handling only the corners and edges, allowing the entire surface area to be examined for visible or partial prints. If any prints are visible at this point, they should be documented with photography before attempting to remove any soot.

The second step involves the removal of soot from the substrate. If the substrate is heavily coated with soot, the item may be held under a gentle stream of running water. Once again, the substrate is visually examined for the presence of prints. Before continuing, allow the substrate to air-dry. After the item has completely dried, the processor may use either lifting tape or a feather brush to remove the remaining layers of soot. The decision whether to use tape or a brush will depend on the condition of the substrate and the processor's experience. The removal process continues until prints are revealed or the original surface of the substrate is visible. (If the item surface is not heavily coated with soot, the rinsing step may be omitted.)

The third step is documentation. Any prints uncovered must be photographed. However, because the fingerprints have been etched into the substrate, the chance of a complete, successful lift is doubtful. Recall that a properly captured image will:

- Fill the frame
- Maximize depth of field
- Include a scale

If the prints are photographed, a photography log should be considered.

Materials

- Digital camera, if recovered prints are to be documented through photography
- Scale of reference, if recovered prints are to be documented through photography
- Tripod, if recovered prints are to be documented through photography
- Photography log, if recovered prints are to be documented through photography

Procedure

1. Create a workstation with butcher paper to protect the surface of the work area.
2. Visually examine the substrate provided by the instructor for prints. If prints are visualized, photograph them, if desired by the instructor. Recall that a properly captured image will:
   - Fill the frame
   - Maximize depth of field
   - Include a scale
3. Determine the condition of the substrate surface and notate as heavily or lightly soot covered.
4. Attempt to remove soot via one or several of the following methods:
   - Gently running water over surface (substrate should be completely dry before using the subsequent methods)
   - Removal with lifting tape
   - Removal with feather brush
5. Continue the process of soot removal until prints are revealed or the original surface of the item is visible.
6. Document prints with photography, if desired by the instructor. Use a photography log if prints are photographed.
7. Complete the Post Lab Questions.

Photography Log						
Activity:		Photographer:				
Date:		Location:				
Camera used:					Time start:	Time end:
Photo No.	ISO	Aperture	Shutter Speed	Lens	Subject Description	

Post Lab Questions

1. What are the components of the fire tetrahedron?
2. What are the challenges associated with fire scenes?
3. Why might lighting be a problem?
4. How do fingerprints survive the fire?
5. What techniques are used to remove soot from the object(s) containing fingerprints?

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James, Stuart H., and James J. Nordby. 2009. *Forensic Science: An Introduction to Scientific Investigative Techniques*. Boca Raton, FL: CRC Press.

Chapter 11

Basic Skills for Scene Processing Impression Evidence

Key Terms

Impression evidence
Toolmark
Footwear impression
Dust print
Casting compound
Dental stone
Gelatin lifter
Known standards

Learning Outcomes

1. Describe the difference between a three-dimensional impression and a two-dimensional print.
2. Explain how the photographic documentation for impressions and prints differs in relation to additive light.
3. Explain why impression standards are important and how they are used.

11.1 Impression Casting: Dental Stone

Objective

- Understand the applicability of dental stone as a casting medium.
- Develop good techniques for casting impressions.
- Practice casting impressions.

Concept Overview

Impression evidence is extremely valuable, as it can link the source of the impression to the location of the impression (i.e., a crime scene). This affirmative link compels the investigator to properly document and collect the evidence. Impression evidence can be discovered in two forms: two-dimensional and three-dimensional impressions. Two-dimensional impressions are found when a substance has been deposited onto a surface but does not leave an indentation. Evidentiary samples are created when a substance such as blood, dirt, oil, etc. is acquired on a medium and deposited onto nongiving surfaces such as tile, linoleum, or wood. Three-dimensional impressions are those that remain after an object has deformed the surface. In regard to shoes, this type of impression is generally found outdoors in mediums such as sand, dirt/soil, or snow.

Impression evidence is documented through photography. When photographing impressions, a tripod is necessary to stabilize the camera, and the camera must be positioned perpendicular (90 degrees) to the impression. Oblique (side) lighting is the technique that uses shadows to enhance the details of the impression. Oblique lighting is achieved when a light source (off-the-camera flash or flood light) is held several feet away from the impression at an angle of 45 degrees or less. A series of at least three images are taken of each impression using oblique lighting. The arrows in Figure 11.1 indicate the direction and location of the light source for each image series.

While these images are captured, the only moving variable is the light source. The camera does not move from its original position on the tripod. Furthermore, the camera's timer or a cable release cord is used to activate the camera rather than physically touching the camera and introducing camera shake, which will produce a blurry image.

Because these photographs may be examined by an impression expert, the images captured should be examination-quality photographs. As such, ISO 100 should be used for maximum quality if enlargements are made, and f/16 or f/22 should be used to maximize the depth of field. The shutter speed is not imperative, as the camera is stabilized on a tripod. Furthermore, the impression should fill the frame, and a scale, ideally an L-scale, should be included.

Materials

- Writing utensil
- Digital camera, if impressions are to be photographically documented
- Tripod, if impressions are to be photographically documented
- Off-the-camera flash or a flood light for oblique lighting, if impressions are to be photographically documented
- Scale of reference, if impressions are to be photographically documented

Procedure

1. Place the substrate (sand, dirt) into/onto a disposable pan.

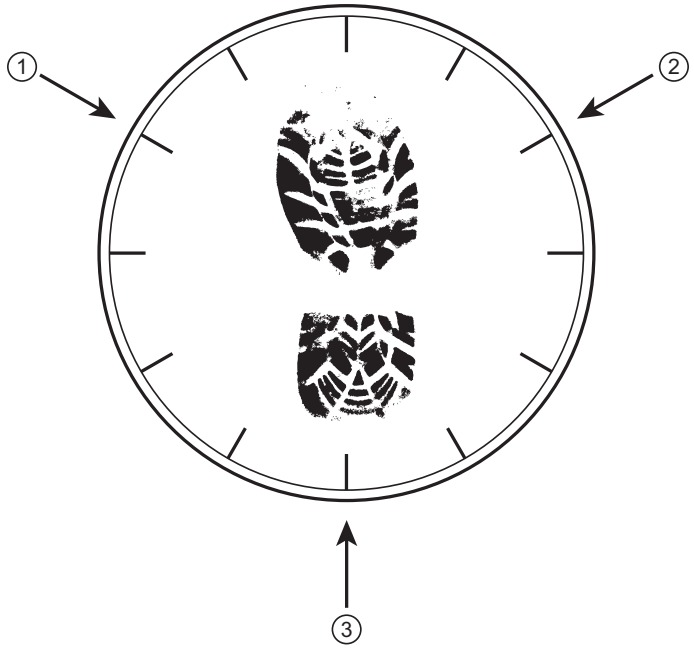


Figure 11.1
Lighting positions when photographing impressions.

2. Create a footwear or tire impression in the medium.
3. Photograph the impression before casting, if desired by the instructor. The equipment needed will be:
   - Digital camera
   - Tripod
   - Off-the-camera flash or flood light for oblique lighting
   - Scale of reference
   - Cable release cord or camera timer function

   The camera settings will be manual setting, ISO 100, f/16 or f/22, and the shutter speed will be dictated by the exposure-level scale. A properly captured image will:
   - Fill the frame
   - Maximize depth of field
   - Include a scale
4. Mix the casting medium to the consistency of pancake batter according to one of the following ratios:
   - 2 pounds of dental stone + 9 ounces of water
   - 2½ pounds of dental stone + 11–12 ounces of water
5. Pour the medium *into* the impression from one end of the impression. Do not pour the casting medium *on top of* the impression, as the weight of the medium could destroy impression detail.
6. Allow the medium to set and dry for at least 3–4 hours before attempting to lift. Take care when lifting to avoid breakage. The cast will continue to dry and cure for the following 48 hours.
7. Complete the Post Lab Questions.

Post Lab Questions

1. Why is the consistency of the dental stone important?
2. Why is it important to photograph an impression before casting?
3. Can impression evidence be classified as class, individual, or both?
4. Why is it important to have both photographs and casts of an impression?

11.2 Impression Casting: Mikrosil

Objective

- Understand the applicability of Mikrosil as a casting compound.
- Develop good techniques for casting impressions with Mikrosil.
- Practice casting impressions with Mikrosil.

Concept Overview

Impression evidence is extremely valuable, as it can link the source of the impression to the location of the impression (i.e., a crime scene). This affirmative link compels the investigator to properly document and collect the evidence.

Impression evidence is documented through photography. When photographing impressions, a tripod is necessary to stabilize the camera, and the camera must be positioned perpendicular (90 degrees) to the impression. Oblique (side) lighting is a technique that uses shadows to enhance the details of the impression. Oblique lighting is achieved when a light source (off-the-camera flash or flash light) is held several feet away from the impression at an angle of 45 degrees or less.

Because these photographs may be examined by an impression expert, the images captured should be examination-quality photographs. With the camera mounted to a tripod, adjust the camera settings as follows for an impression. ISO 100 should be used for maximum quality and in the event that enlargements are made; for f/stop, set to f/16

or f/22 to maximize the depth of field. For prints/marks on flat surfaces, the f/stop may be set to f/8 or f/11 as the depth of field is shallower. For impressions and marks, the shutter speed will vary based on the nature/shape of the item photographed and the ambient light. A good starting baseline for shutter speed is to adjust to 0 on the exposure-level scale of the camera. Finally, before photographing, confirm that the impression fills the frame with a reference scale parallel to it.

Mikrosil is a silicone casting compound used to cast impression evidence such as three-dimensional toolmarks and two-dimensional fingerprints on textured surfaces. The casting medium is sold through forensic vendors as a kit that includes Mikrosil, a hardener, a mixing pad, and a wooden utensil for mixing the compound. After application, the cast will set and dry in several minutes.

Materials

- Writing utensil
- Digital camera, if impressions are to be photographically documented
- Tripod, if impressions are to be photographically documented
- Off-the-camera flash or flash light for oblique lighting, if impressions are to be photographically documented
- Scale of reference, if impressions are to be photographically documented
- Mikrosil kit
- Object with an impression or print for casting

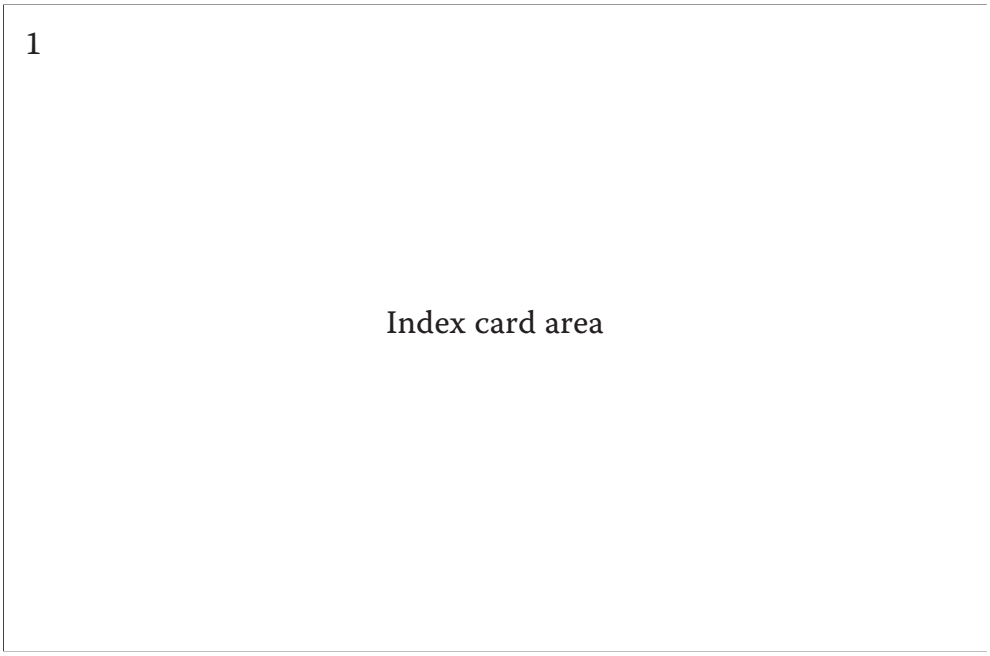
Procedure

1. Examine the toolmark impression or fingerprint evidence on the substrates presented by the instructor.
2. Document the impression(s) with photography (if desired by the instructor). The equipment needed will be:
   - Digital camera
   - Tripod
   - Off-the-camera flash or flash light for oblique lighting
   - Scale of reference
   - Cable release cord or camera timer function

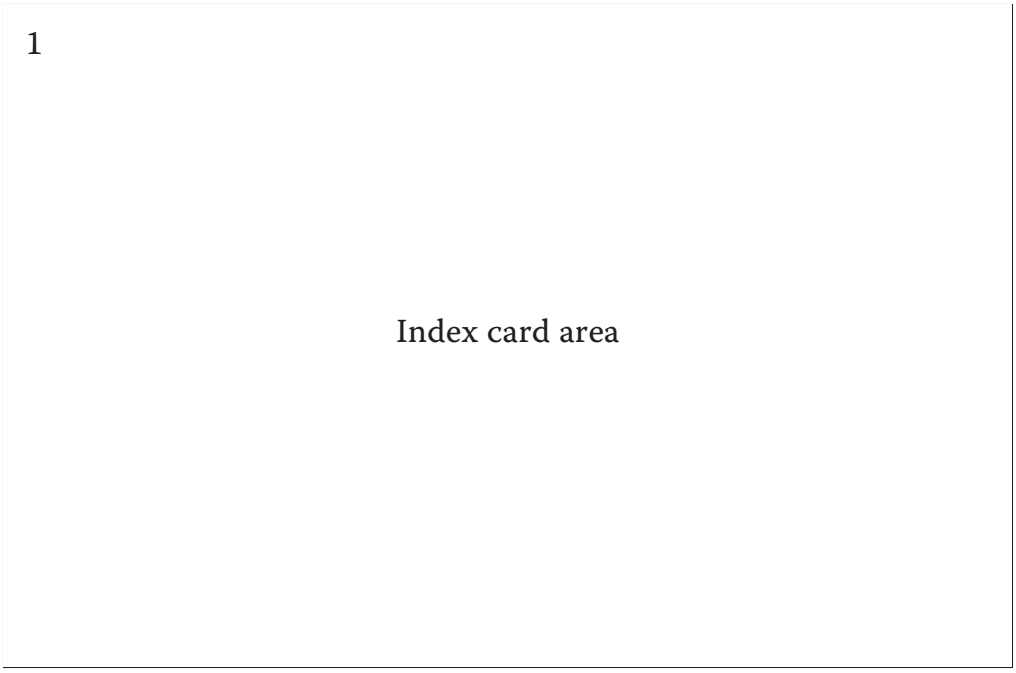
   The camera will be on the manual setting, ISO 100; the aperture will range from f/8 to f/22 depending on the substrate provided; and the shutter speed will be dictated by the exposure-level scale. A properly captured image will:
   - Fill the frame
   - Maximize depth of field
   - Include a scale
3. Mix and apply the Mikrosil compound as follows:
   - Squeeze the Mikrosil tube to release the desired amount in a straight line on the mixing pad.
   - In a parallel line next to the Mikrosil, release the hardener from its tube so that it is the same length as the Mikrosil.
   - Use the wooden utensil to mix the two components.
   - After mixing, use the utensil as a tool to spread the Mikrosil compound over the impression.
   - Allow the compound to dry for 5–10 minutes.
   - Lift the dry medium and flip it over to see the cast impression.
   - Preserve the cast by placing it on an index card, impression side up, and use clear fingerprint tape to secure it to the card.
   - Affix the index card to the Processing Worksheet.
4. Complete the Post Lab Questions.

Processing Worksheet

Mikrosil



Substrate type:
Comments:



Substrate type:
Comments:

Post Lab Questions

1. Compare and contrast Mikrosil and dental stone.
2. Which process was easier to use?
3. After using both methods, which process showed the most detail?
4. If too much hardener is added to the Mikrosil mix, what will happen?

11.3 Print Lifting: Gelatin Lifter

Objective

- Understand the applicability of gelatin lifters as a tool for lifting prints.
- Develop good techniques for lifting prints with gelatin lifters.
- Practice lifting prints with gelatin lifters.

Concept Overview

Two-dimensional print evidence, such as fingerprints and shoe dust prints, are extremely valuable, as they can link the source of the prints to the location of the prints (i.e., a crime scene). This affirmative link compels the investigator to properly document and collect the evidence.

Prints should be documented through photography. Because these photographs may be examined by a fingerprint or footwear expert, the images captured should be examination-quality photographs. When capturing these types of images, a tripod is necessary to stabilize the camera, and the camera must be positioned perpendicular (90 degrees) to the print. Oblique (side) lighting is a technique that uses shadows to enhance the details of the print, when necessary. It is achieved when a light source is held away from the impression at an angle of 45 degrees or less. The exact position of the light source is determined as the photographer views the print through the camera viewfinder. The visual quality of the print will change with the movement of the light. When the visualization of the print is optimal, the correct light position has been located and should be fixed. For shoe dust prints, the best position for the additive white or UV light is oblique lighting or behind the print where the light strikes across the same plane as the print.

With the camera mounted to a tripod, adjust the camera settings as follows to record the print. ISO 100 should be used for maximum quality and in the event that enlargements are made. For f/stop, set to f/16 or f/22 to maximize the depth of field for curved objects. For prints/marks on flat surfaces, the f/stop may be set to f/8 or f/11 as the depth of field is shallower. The shutter speed will vary based on the nature/shape of the item photographed and the ambient light. A good starting baseline for shutter speed is to adjust to 0 on the exposure-level scale of the camera. Finally, before photographing, confirm that the impression fills the frame with a reference scale parallel to it.

Gelatin lifters are flexible and adhesive and can address surfaces with prints deposited in contaminants such as oil, dirt, or grease, as well as shoeprints deposited by dust. Gel lifters can be cut to size to accommodate small prints and to preserve the remaining portion of the lifter for future use. They come in various colors, so the color used for lifting should offer contrast for the color of the developed print.

Materials

- Writing utensil
- Digital camera, if impressions are to be photographically documented
- Tripod, if impressions are to be photographically documented

- Off-the-camera flash or flash light for oblique lighting, if impressions are to be photographically documented
- Scale of reference, if impressions are to be photographically documented
- Gelatin lifter
- Object with a print for lifting

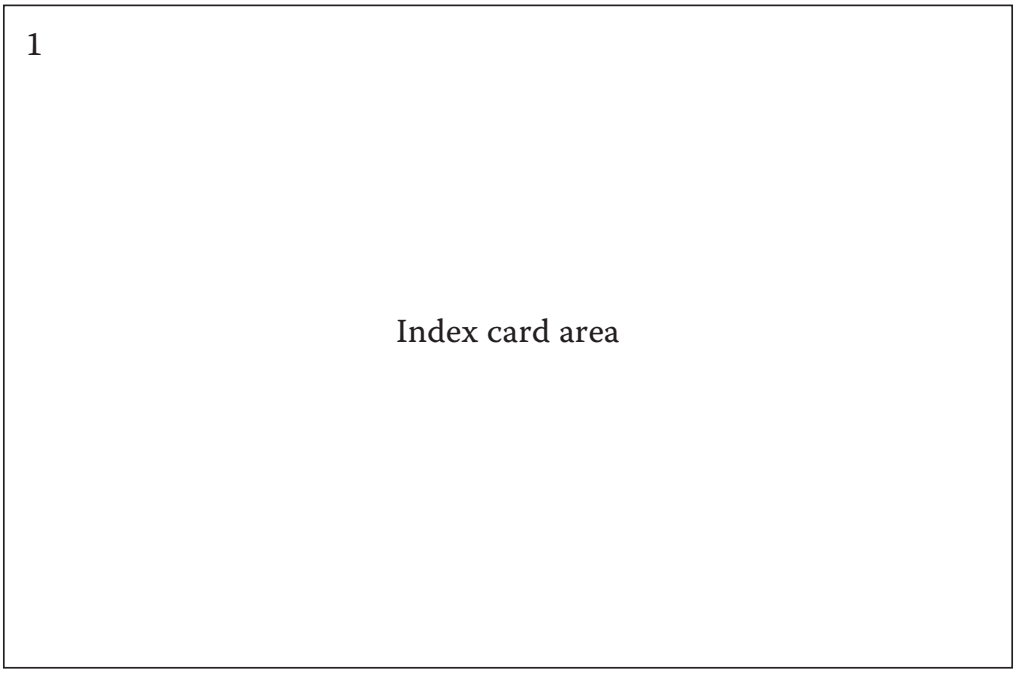
Procedure

1. Examine the print evidence on the substrates presented by the instructor.
2. Document the print(s) with photography (if desired by the instructor). The equipment needed will be:
   - Digital camera
   - Tripod
   - Flash light for oblique lighting, if necessary
   - Scale of reference
   - Cable release cord or camera timer function

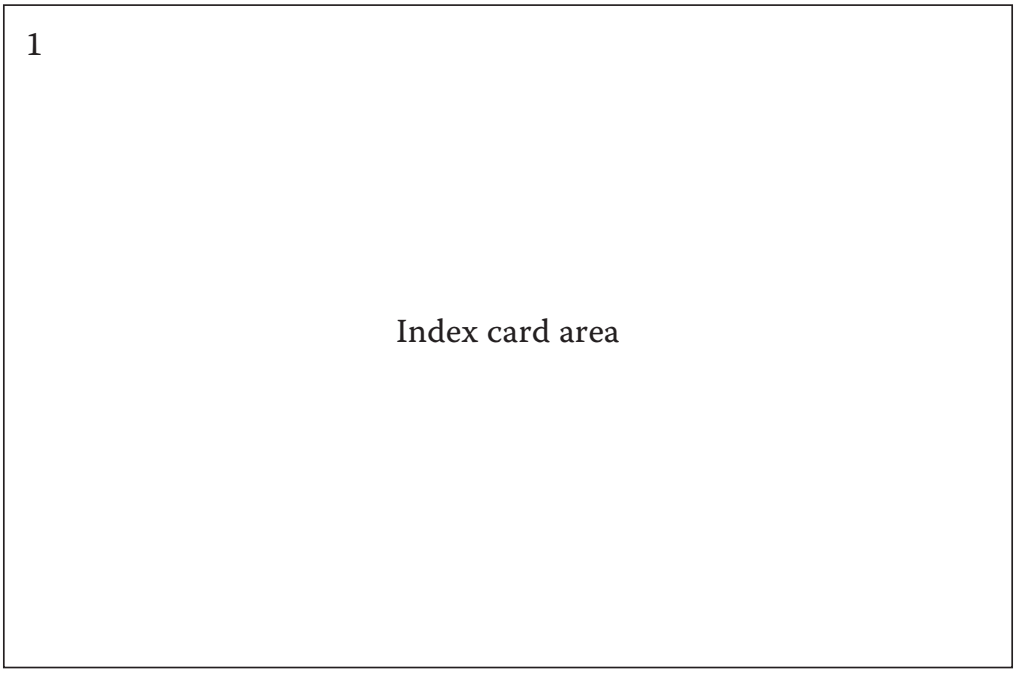
   The camera will be on the manual setting, ISO 100; the aperture will range from f/8 to f/22 depending on the substrate provided; and the shutter speed will be dictated by the exposure-level scale. A properly captured image will:
   - Fill the frame
   - Maximize depth of field
   - Include a scale
3. Use the gelatin lifter as follows:
   - Search the surface of the substrate and locate the print (this may require the introduction of additive light).
   - Remove the clear covering from the gel side of the lifter. (The side in contact with the gel should be laid aside facing up.)
   - Determine how to lay the lifter onto the print. This is determined by the nature and size of the surface and print. Two options are:
     - Hold the lifter with one hand at each of the ends, and let it bow in the center to form a U shape. Allow the base of the U to contact the surface, and then smooth the rest of the lifter over the surface.
     - Hold the lifter with one hand at each of the ends, and anchor one end to the surface behind the developed print. Smooth the rest of the lifter over the surface.
   - Use a clean ink roller to roll over the lifter. This removes air bubbles and confirms good contact between the print and lifter.
   - For prints developed with powder or highly visible contaminants such as oil and grease, remove the lifter from the surface by lifting one end and gently pulling back. For dust prints or prints with very low visibility, let the lifter sit on the surface for approximately 10 minutes. This allows the print deposit to absorb into the gelatin of the lifter.
   - Lay the lifter on a flat surface with the print side up.
   - Place the clear covering back onto the gelatin side of the lifter.
   - Maintain the lift by placing it on an index card, print side up, and use clear fingerprint tape to secure it to the card.
   - Affix the index card to the Processing Worksheet.
4. Complete the Post Lab Questions.

Processing Worksheet

Gelatin Lifter



Substrate type:
Comments:



Substrate type:
Comments:

Post Lab Questions

1. What angle of light should be used to view two-dimensional prints?
2. What are gel lifters?
3. When should gel lifters be used?

11.4 Collecting Known Standards: Footwear Standards

Objective

- Understand the necessity of known standards.
- Identify various methods of collecting known footwear standards.
- Practice collecting known footwear standards.

Concept Overview

For comparison purposes, it is imperative to have a known standard or an item that is from a known source. Examples of known standards are hair, soil, glass, and fingerprints. Each type of evidence has specific protocols for collection, packaging, and preservation. It is imperative for those who collect this evidence be aware of these protocols and adhere to them. Improperly collecting known standards renders them useless for comparison purposes, and the linkage between the known source and the crime scene or evidentiary item cannot be established.

For footwear sole comparison, known standards must be collected, and there are several ways to collect them. The most desirable method is for the footwear itself to be collected. Another collection method is the use of an inkless ink pad for inking the sole and then stepping onto an impression card or thick card stock. Impression foam may also be used. The wearer steps into the foam, and the foam records the tread and details of the sole. For any collection methods with which the collector is not familiar, it is advisable to practice prior to collecting the actual known standard.

Materials

- Writing utensil
- "Suspect" shoes
- Cooking spray
- Copy paper
- Magnetic powder and applicator

Procedure

1. Collect the materials needed for collection of the known footwear standard.
2. Spray the known footwear sole with cooking spray.
3. Have the wearer stand on a piece of copy paper.
4. Dust the copy paper with magnetic paper.
5. Preserve the developed print through photography.
6. Lift the print with a gelatin lifter, if desired.
7. Complete the Post Lab Questions

Post Lab Questions

1. What is a known standard?
2. Why are known standards collected?
3. What types of evidence need to have known samples collected?
4. Describe each of the methods used to collect known samples.

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Chapter 12

Shooting Scenes Evidence and Documentation

Key Terms

Internal ballistics
Terminal ballistics
External ballistics
Forensic firearms examiner
Forensic pathologist
Penetrating injury
Perforating injury
Tangential injury
Grazing injury
Penetrating defect
Perforating defect
Ricochet
Tangential defect
Trajectory rod
Trajectory analysis

Learning Outcomes

1. Identify common firearms and ballistics terminology.
2. Explain the difference between internal, terminal, and external ballistics.
3. Explain the roles of the forensic pathologist and firearms examiner as they pertain to shooting investigations.
4. Describe several ways to determine the angle of impact of a bullet strike.

12.1 Application of Firearms and Ballistics Terminology

Objective

- Explain the importance of knowing firearms and ballistics terminology.
- Explain the difference between a semiautomatic firearm and a revolver.
- Practice identifying the anatomy of firearms.

Concept Overview

Investigators must be able to recognize and identify evidence within a crime scene. While this may seem somewhat overwhelming due to the numerous types of evidence, it is imperative nonetheless. Failing to recognize evidence and subsequently collect it can have a very negative impact on an investigation.

One prevalent category of evidence is firearms and ballistics. It is important for the investigator to understand that there are many different types of firearms, and a good deal of them operate differently from each other. The two main categories of firearms are handguns (semiautomatic and revolvers) and long guns (rifles and shotguns). The majority of the time, handguns are the firearms encountered during criminal investigations, specifically semiautomatic firearms. Some of the differences between a semiautomatic and a revolver are:

- Semiautomatics hold their ammunition in a magazine.
- Revolvers have a cylinder that houses their ammunition.
- Revolvers don't suffer from as many malfunctions.
- Revolvers are, for the most part, point-and-shoot weapons.
- Semiautomatics, generally speaking, have greater ammo capacity.

To be as effective as possible, the investigator should have a working knowledge of the anatomy of firearms as well as how they function. Just as important is knowledge of the anatomy and composition of various types of ammunition, which will vary depending on whether the ammunition is for handguns or long guns.

Familiarity with the functionality of firearms can assist the investigator with knowing and understanding what is and is not possible in terms of actions in and events of a scene. This knowledge can also assist the investigator when assessing the validity and veracity of statements made by those involved in a criminal investigation.

Materials

- Writing utensil

Procedure

1. Review Firearms and Ballistics Terminology.
2. Examine the provided firearms and ammunition illustrations (Figures 12.1 through 12.6).
3. Identify and label the parts of the firearms and ammunition. Refer to the terminology section, if necessary.
4. Complete the Post Lab Questions.

Firearms and Ballistics Terminology

Barrel: A tube, sealed at one end (the breech), in which a propellant is ignited, whose rapidly expanding gases create powerful pressure to force a single or multiple projectiles through its bore, out the open end (the muzzle) and down range toward a target.

Brass: The casing on rifle and pistol ammunition, usually made of brass. (Shotgun shell casings are typically referred to as a hull.)

Cartridge: The assembly consisting of a bullet, gunpowder, shell casing, and primer.

Cartridge case/shell casing: A hollow piece of metal (or plastic for a shotgun shell) that is closed on one end except for a small hole that holds a primer. The open end holds the bullet. The hollow portion holds the powder. Together the assembled unit is called a cartridge.

Cylinder: The part that holds cartridges in separate chambers radially around a central hinge pin. The cylinder revolves as the handgun is cocked, bringing each successive cartridge into position, and locks into alignment with the barrel for firing.

Ejection port: An opening through which empty, spent ammunition cases are thrown out of the firearm after firing.

Figure 12.1
Semiautomatic firearm.

Figure 12.2
Revolver.

Figure 12.3
Ammunition—handgun cartridge.

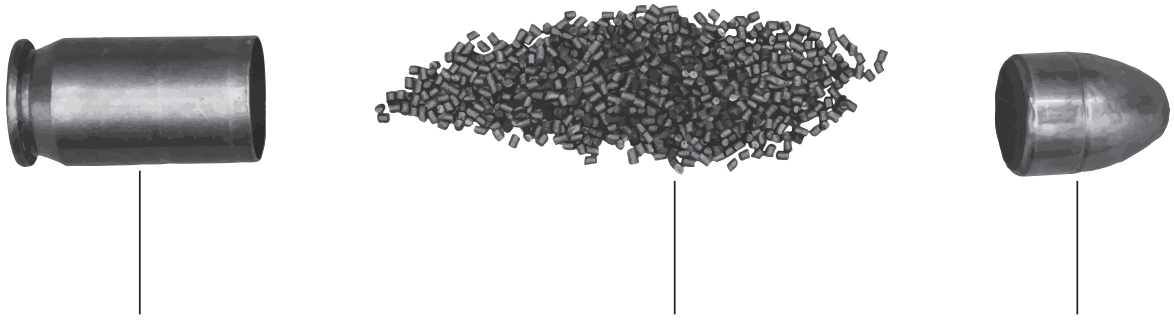

Figure 12.4
Ammunition—handgun cartridge components.

Figure 12.5
Ammunition—shotgun cartridge.

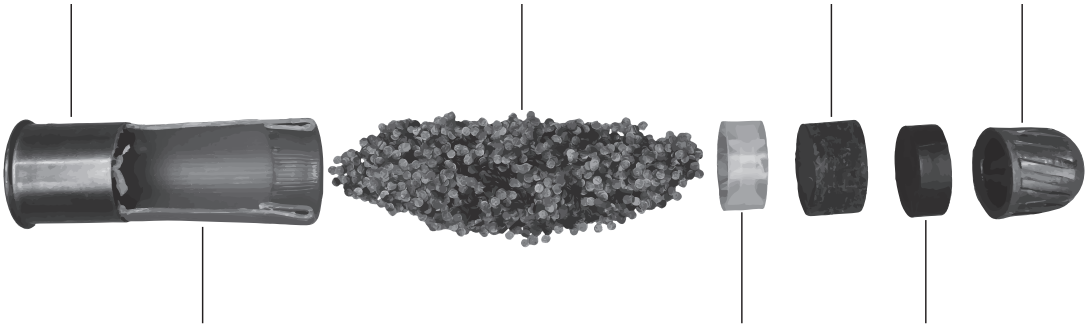

Figure 12.6
Ammunition—shotgun cartridge components.

Frame: Metal part of the firearm that houses internal components. Typically where the serial number is located.

Grip: The area of a gunstock held by the shooter's rearmost hand.

Gunpowder: Smokeless propellant powder present in ammunition.

Hammer: The part of a gunlock that is driven by a spring and released by the pull of the trigger, causing it to fall and strike the detonating primer of the load, discharging the gun.

Hull: Casing of a shotgun shell (also referred to as brass).

Magazine: A spring-operated reservoir for cartridges for a repeating firearm.

Muzzle: The end of a barrel, pointing toward the target, out of which the load is discharged.

Primer: A small metal cup placed at the base of a shell casing, containing an explosive charge sensitive to impact. It is detonated by the striking of a firing pin of a firearm.

Projectile: A bullet in flight after discharge from a firearm.

Safety: A device that, when engaged, should prevent the discharge of the firearm.

Shot: Multiple pellets contained in the shell and sent downrange when the shotgun is fired.

Shotgun shell/shotshell: Cartridge for a shotgun, usually made of plastic.

Sight: Small accessory fitted to the frame, barrel, and/or slide of a firearm as an aid to aiming. They can be located at the rear and/or front of the firearm.

Slide: Portion of the firearm that moves back and forth when the weapon is fired. Ejects fired cases and aids in loading the next cartridge.

Slug: An individual cylindrical projectile designed to be discharged from a shotgun.

Trigger: The small lever on a firearm, which one pulls to cause the spring-loaded firing pin to impact the primer, causing the gun to discharge.

Trigger guard: A bow-shaped flange, normally made of steel, designed to cover the trigger well enough to reduce the possibility of accidental discharge.

Wad: A felt, paper, cardboard, or plastic disk that is used in a shotshell.

Post Lab Questions

1. What are the two main categories of firearms?
2. Name two differences between semiautomatics and revolvers.
3. What is the difference between a cartridge and a shell casing?
4. What is the purpose of the primer?

12.2 Who Gets the Assignment?

Objective

- Explain the difference between internal, terminal, and external ballistics.
- Identify who performs ballistics-related tasks.

Concept Overview

Shooting scenes can be fairly simple or very complex in nature. They can range from one shot being fired to dozens of shots being fired by numerous people. The perceived complexity is also affected by the investigator's training in such scene events, as well as the amount of experience they have working them.

Shooting events generate a multitude of ballistics or firearms-related evidence. This evidence can be broken down into three categories: internal ballistics, terminal ballistics, and external ballistics. Each area is distinct and is

performed by professionals with specific skill sets. While each category is separate, it is the combination of all findings from each category that provides the best possibility for investigative success.

Internal ballistics is the purview of a firearms examiner. Firearms are assessed and examined to determine whether they are functional and, if so, whether they function properly. These examiners conduct comparisons based on class and individualizing characteristics of firearms, fired cartridge cases, and fired bullets to make science-based opinions on identification. They also examine bullets for trace evidence and damage. During such examinations, examiners look for trace evidence that is layered; this indicates the sequence of the targets as they were struck. Also, damage observed on the bullet can indicate the type of target that was struck.

Terminal ballistics is addressed by a forensic pathologist. When a firearm is discharged, an explosion occurs. In addition to a bullet, a flame exits the barrel of the weapon along with gases, soot, and burnt and unburnt gunpowder. Bullet wounds and other injuries are documented and included in the "Evidence of Injury" section of autopsy reports. Firearm injury documentation also includes the presence and absence of stippling (burnt/unburnt gunpowder particles embedded in the skin), soot, or burning in the wound area. These characteristics and the appearance of the wound(s) directly relate to the distance of a gun muzzle from an entry wound when the weapon was fired. The categories of muzzle ranges are:

- Close or hard contact—The muzzle is directly contacting the skin or pressing into it.
- Loose contact—The muzzle is very near the skin, but there is a gap between them.
- Near contact—The muzzle is 5 inches or less away from the skin.
- Intermediate range—The muzzle is 5–40 inches away from the skin/body.
- Indeterminate range—No conclusion can be drawn. (A bullet wound is present without any other characteristics, such as soot, stippling, or burning.)

Bullet injuries are described as:

- Penetrating—Bullet entry and no exit
- Perforating—Bullet enters and exits
- Tangential—Bullet skims along the skin, creating several wounds
- Grazing—Bullet passes along the skin, leaving an abrasion

All injuries sustained by a decedent are reported by the pathologist in the "Evidence of Injury" section of an autopsy report, and this information is critical in crime scene reconstruction and shooting incident reconstruction.

External ballistics relates to the trajectory or path of a bullet upon exiting the firearm. This determination is the task of the crime scene investigator. The ability to ascertain the trajectory depends on the surface or target the bullet struck and whether the bullet was tumbling when it struck the target. There are occasions when deriving a trajectory is not possible. Bullet defects are described as:

- Penetrating defect—Bullet enters and does not exit
- Perforating defect—Bullet enters and exits
- Ricochet/deflection—Bullet strikes a surface without penetrating it completely and deflects off of it
- Tangential defect—Bullet skims a surface, creating several defects
- Exit—The site where the bullet leaves the body

Regardless of the type of defects present, it is imperative that they, and all related firearms evidence, be documented thoroughly through photographs and sketches.

Materials

- Writing utensil

Procedure

1. Read the news briefs from the *Penville County Tribune*.
2. For each superscript in the news briefs, identify who is to perform the task or who is associated with the event.
3. Complete the Ballistics Assignments table.
4. Complete Post Lab Questions.

Penville County Tribune: News Briefs

Penville County—A chilling crime took place in the early hours Thursday night. An unknown person or persons broke into a residence in the Blue Lakes subdivision and killed several of the residents.

Neighbors say they heard what they thought were fireworks in the late-night hours. No calls, however, were placed to the sheriff's office about the noise.

According to police, the residence was a scene of gun violence. Two members of the family of six are missing. Investigators are still at the residence documenting the ballistics evidence and searching for clues.[1]

A source close to the investigation said that two adults and two teenagers were each killed by gunshot wounds. The victims will be transported for autopsies.[2]

A search is underway for the remaining family members who are missing. It was stressed that the missing persons are not considered suspects.

Penville County—On September 19, gruesome murders rocked the sleepy town of Chester when most of a family residing in the Blue Lakes subdivision was discovered murdered.

The residence is still the site of criminal investigation, where investigators have been working for days. An unnamed source told the *Penville County Tribune* that there were numerous gunshots fired inside the residence, and investigators are focusing their efforts on what that evidence will reveal.[3]

The victims were transported to the Jacoby County Medical Examiner's Office, where Chief Medical Examiner Dr. K. Cruse conducted the autopsies, searching for clues to assist in the investigation. According to preliminary findings, the victims appeared to have been beaten and shot.[4]

Penville County—The yellow-and-black barrier tape that has encircled the McCoy residence for nearly four days has now been removed. The law enforcement vehicles that seemingly camped out at the residence have now gone, leaving this once quiet community shaken.

According to neighbors, several investigators were seen late last night carrying out multiple long guns and small boxes. One investigator confirmed that the weapons would be examined to determine if they were involved in the McCoy murders.[5]

The remaining family members, Johnson McCoy (16) and Jennifer McCoy (18), are still missing. The search for these two possible witnesses is still underway. If you have any information as to their whereabouts, you are asked to call 311-555-TIPS.

Penville County—The search for Johnson and Jennifer McCoy ended early this morning when their bodies were discovered in a vehicle near the Penville/Absaroka County line.

A source requesting anonymity stated the scene was grisly. The vehicle was riddled with bullet holes, and the brother and sister had succumbed to gunshot wounds.

Dr. Cruse of the Jacoby County Medical Examiner's Office traveled to the site of the carnage to personally oversee the transport. According to our sources, the autopsies are scheduled for tomorrow at 10:00 a.m.[6]

Penville County investigators are making preparations to tow the vehicle to their facility's processing bay to assess and examine the vehicle.[7]

Penville County—At 3:00 p.m. today, Penville County Sheriff David Hickson held a news conference concerning what is now week two of the McCoy multiple murder case.

Sheriff Hickson confirmed a finding by Chief Medical Examiner Dr. K. Cruse that all six members of the McCoy family died from gunshot wounds.[8]

Sheriff Hickson also confirmed that examination of bullets recovered from the bodies of the victims revealed that they were all shot with the same gun.[9]

Sheriff Hickson stated that the investigation is continuing, and he will share more information at a future time.

Penville County—A funeral was held today for the McCoy family members who were the victims of a still unsolved murder case. Hundreds of people attended the service to show respect and share fond memories.

Investigators, meanwhile, are still trying to solve this shocking crime. One investigator, speaking off the record, said that she believes the recovered vehicle, in which two of the McCoy family members were discovered, holds crucial evidence.

Tomorrow investigators will begin the arduous task of documenting the vehicle and its numerous bullet holes.[10] Meanwhile, the weapon used in this case has yet to be found. If you have any information about this case, you are asked to call 311-555-TIPS.

Ballistics Assignments

Superscript No.	Task/Event	Ballistics Area	Profession
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Post Lab Questions

1. How do a perforating and penetrating defect differ?
2. What are the three categories of ballistics evidence?
3. Define internal ballistics.
4. What is a tangential defect?

12.3 Wound Identification

Objective

- Describe the information derived from terminal ballistics.
- Describe the categories of muzzle ranges.
- Practice identifying bullet wound injuries.

Concept Overview

Shooting events generate a multitude of ballistics or firearms-related evidence. This evidence can be broken down into three categories: internal ballistics, terminal ballistics, and external ballistics. Each area is distinct and is performed by professionals with specific skill sets. While each category is separate, it is the combination of all findings from each category that provides the best possibility for investigative success.

Terminal ballistics is addressed by a forensic pathologist. When a firearm is discharged, an explosion occurs. In addition to a bullet, a flame exits the barrel of the weapon along with gases, soot, and burnt and unburnt gunpowder. Bullet wounds and other injuries are documented and included in the "Evidence of Injury" section of autopsy reports. Firearm injury documentation also includes the presence and absence of stippling (burnt/unburnt gunpowder particles embedded in the skin), soot, or burning in the wound area. These characteristics and the appearance of the wound(s) directly relate to the distance of a gun muzzle from an entry wound when the weapon was fired. The categories of muzzle ranges are:

- Close or hard contact—The muzzle is directly contacting the skin or pressing into it. The edges of the wound are burnt and blackened by soot. A wound track is created in the body, and within this track is evidence of the material that exited the firearm's barrel. Depending on the thickness/thinness of the skin damaged by a bullet, there may be a muzzle print visible or a stellate, or star-shaped, wound.
- Loose contact—The muzzle is very near the skin, but there is a gap between them. The bullet hole will have a soot ring around it. The soot surrounding this wound is removable.
- Near contact—The muzzle is 5 inches or less away from the skin. The bullet hole is surrounded by burnt skin and a soot ring. The soot ring from this muzzle range is much wider than that of the loose contact wound.
- Intermediate range—The muzzle is 5–40 inches away from the skin/body. The entrance wound has stippling or powder tattooing around it. This injury is actually composed of abrasions on the skin resulting from the impact of powder grains against the skin. As this is an injury, it is a permanent condition that cannot be altered by washing/cleaning during the autopsy procedure. Tattooing is orange to red in color.
- Indeterminate range—No conclusion can be drawn. The bullet wound is round to oval in shape with sharp margins, and there is an abrasion ring visible. The abrasion ring results from the bullet impacting and penetrating the skin. There is no soot, stippling, or burning present.

Bullet injuries are described as:

- Penetrating—Bullet entry and no exit.
- Perforating—Bullet enters and exits.
- Tangential—Bullet skims along the skin, creating several wounds.
- Grazing—Bullet passes along the skin at a shallow angle and leaves an elongated abrasion.
- Exit—The site where the bullet exits the body. It is typically larger and more irregular than entrance wounds, as the bullet has become destabilized traveling through the wound track, and it is exiting with material such as skin, tissue, blood, and bone.

All injuries sustained by a decedent are reported by the pathologist in the "Evidence of Injury" section of an autopsy report, and this information is critical in crime scene reconstruction and shooting incident reconstruction.

Materials

- Writing utensil

Procedure

1. Read the "Evidence of Injury" excerpts from the autopsy reports.
2. Based on the information provided, determine the type of bullet injury and muzzle range for each decedent.

3. Input the data in the Injury Type and Muzzle Range table.
4. Complete the Post Lab Questions.

Autopsy Excerpt: Glenn McCoy

EVIDENCE OF INJURY:

A. GUNSHOT WOUND OF THE HEAD

A 1½ × 1½–inch gunshot wound is on the posterior medial occipital region, 68½ inches from the sole of the right foot. A soot ring is visible around the wound.

The projectile enters the calvarium through the occipital bone damaging cervical vertebrae C1, C2, and C3. The manubrium is shattered where a deformed lead alloy projectile is retrieved. The overlying skin is swollen and reddish brown.

Autopsy Excerpt: Kelly McCoy

EVIDENCE OF INJURY:

A. GUNSHOT WOUND OF THE CHEST

A 1 × 1–inch gunshot wound is on the left anterior thorax, 49 inches from the sole of the right foot. Orange/reddish-colored punctate abrasions are visible near the wound.

The projectile enters the body cavity at the anterior left fourth rib, 1½ inches from the medial line. The left ventricle of the heart is perforated. Thoracic vertebrae T7 and T8 are shattered. The projectile exits the dorsal body cavity 48 inches from the sole of the right foot, 1¾ inches left of the medial line. The wound is 2 × 2½ inches.

Autopsy Excerpt: Kaden McCoy

EVIDENCE OF INJURY:

A. GUNSHOT WOUND OF THE ABDOMEN

A ½ × ¼–inch gunshot wound is on the anterior left abdomen, 4 inches from the medial line and 34½ inches from the sole of the right foot. The wound is oval in shape with sharp margins; an abrasion ring is visible. The wound is not associated with gunpowder residue or stippling.

The projectile enters the body cavity through soft tissue perforating the transverse colon, small intestine, and ascending colon. The projectile exits the body cavity through soft tissue on the anterior right abdomen 3¼ inches from the medial line and 34 inches from the sole of the right foot. The wound is 1 × 1½ inches.

Autopsy Excerpt: Gregory McCoy

EVIDENCE OF INJURY:

A. GUNSHOT WOUND OF THE BACK

A ¾ × ½–inch gunshot wound is on the posterior dorsum at the medial line, 42 inches from the sole of the right foot. The wound is round in shape with sharp margins; an abrasion ring is visible. The wound is not associated with gunpowder residue or stippling.

The projectile enters the body cavity at the thoracic vertebra T2. The heart, lungs, and diaphragm are perforated. The sternum is fractured where a deformed lead alloy projectile is retrieved. The overlying skin is swollen and reddish brown.

Autopsy Excerpt: Jennifer McCoy

EVIDENCE OF INJURY:

A. GUNSHOT WOUND OF THE HEAD

A 1 × ¾–inch gunshot wound is on the anterior frontal region at the medial line, 64 inches from the sole of the right foot. The wound bears a muzzle imprint and the wound edges are blackened.

The projectile enters the calvarium through the frontal bone. The parietal bone is fractured. The frontal, parietal, and occipital lobes are perforated. The occipital lobe is fractured 63½ inches from the sole of the right foot where a deformed lead alloy projectile is retrieved.

Autopsy Excerpt: Johnson McCoy

EVIDENCE OF INJURY:

A. GUNSHOT WOUND OF THE HEAD

A 1 × 1¼–inch gunshot wound is on the right temporal region of the head, 67 inches from the sole of the right foot. A soot ring is visible around the wound; the skin is seared.

The projectile enters the calvarium through the temporal bone. The temporal lobe is perforated. The left temporal bone is shattered. The projectile exits the cranial cavity 67 inches from the sole of the right foot at the temporal region. The wound is 2 × 2½ inches.

Table Injury Type and Muzzle Range

Decedent	Wound Characteristics	Injury Type	Muzzle Range
Glenn McCoy			
Kelly McCoy			
Kaden McCoy			
Gregory McCoy			
Jennifer McCoy			
Johnson McCoy			

Post Lab Questions

1. Describe grazing.
2. Describe loose contact.
3. When a shot is fired at intermediate range, how far away from the skin/body is the muzzle?
4. If no stippling, soot, or burning is present, what category of muzzle range would be noted?

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Chapter 13

Applying Bloodstain Pattern Analysis at the Crime Scene

Key Terms

Angle of impact
Area of convergence
Area of origin
Phenolphthalein
Tetramethylbenzidine (TMB)
O-Tolidine
Hemastix

Learning Outcomes

1. Define bloodstain pattern analysis.
2. Understand the nature of bloodstains.
3. Recognize the various categories and subcategories in which bloodstains can be classified.
4. Understand the importance of determining directionality and impact angle.

13.1 Determining Directionality of Bloodstains

Objective

- Understand the nature of bloodstains in flight.
- Recognize directionality characteristics of bloodstains.
- Practice determining the directionality of bloodstains.

Concept Overview

Bloodstain pattern analysis is a scientific discipline in which blood and bloodstain pattern evidence is examined to determine the nature of the event(s) that created the evidence. The location of the bloodstain evidence is a critical element, as well as identifying the following characteristics of the bloodstains: size, shape, and distribution.

Bloodstain size is the result of an inverse relationship involving the amount of force applied to a blood source. The greater the amount of force applied, the smaller the bloodstains. For example, when a blood source is impacted by a projectile originating from the explosive force of a discharged firearm, the preponderance of the bloodstains in the resulting bloodstain pattern are approximately 1 mm or less in size. When a blood source is impacted with a bludgeoning instrument, such as a pipe or a bat, in motion from manual human force, the preponderance of the bloodstains in

the resulting bloodstain pattern are 1–4 mm in size. Bloodstain size is a characteristic indicative of the nature of the force used in bloodletting events. It must be stressed, however, that a *single* bloodstain cannot be used to conduct an analysis of a scene. Bloodstain *patterns* are examined, and analysis is conducted within the context of the entire scene, not within a vacuum of bloodstain evidence only.

When bloodstains are in flight, they travel in a parabolic arc while under the influence of gravity and affected by their own mass. The heavier they are, the farther they will travel. Bloodstains travel upward until the peak of their parabolic arc is reached, and then they fall downward out of their arc until the bottom of the arc is reached. If bloodstains are allowed to travel in their arcs unimpeded, the resulting shape of the bloodstain upon landing will be circular. If a bloodstain strikes a surface while in flight, the shape of the stain will be the angle at which it was in flight upon impact. Thus, the geometry of a bloodstain defines its *angle of impact*. Resulting characteristics of a bloodstain after impact on a surface can also indicate the *directionality* of the bloodstain. These characteristics include:

- Scallops—An edge characteristic that is wave-like in appearance
- Satellite stains—Small stains originating from a parent stain after impact on a surface
- Tails—An elongated projection of a bloodstain

They are visible on the side of the stain opposite the side that impacted the surface (which is called the leading edge of the stain). Examination of bloodstain directionality can assist in determining the originating location of the stain; examination of bloodstains within an impact pattern can determine the location of a blood source when it received bloodletting impact; and examination of bloodstains can determine the direction someone with a bleeding wound traveled.

Distribution relates to bloodstain *patterns*, not solitary bloodstains. Examination of a bloodstain pattern may assist in determining the object that created the stains, a common area of convergence, or the location of the blood source upon forceful impact.

The single most limiting factor related to bloodstain pattern analysis is the surface texture on which bloodstains land and bloodstain patterns result. For example, with the variables of blood drop volume, distance fallen, and force applied to blood (gravity at 90 degrees), a bloodstain landing on a hard, smooth, nonporous surface would look very different from one landing on a rough, nonporous surface. The stain on the smooth surface would be circular in shape, while the stain on the rough surface would appear distorted and irregularly shaped.

Materials

- Writing utensil

Procedure

1. Examine the figures in the Evaluation Worksheet.
2. For each bloodstain, indicate its directionality by drawing an arrow parallel to the stain.
3. In the area provided, explain and support your determination via the visible characteristics of the stain.
4. Complete the Post Lab Questions.

Evaluation Worksheet

Stain 1

Indicate directionality of the stain by drawing an arrow parallel to the stain.

Support for determination of directionality:_____

_____

_____

_____

Stain 2

Indicate directionality of the stain by drawing an arrow parallel to the stain.

Support for determination of directionality:_____

_____

_____

_____

Stain 3

Indicate directionality of the stain by drawing an arrow parallel to the stain.

Support for determination of directionality:_____

_____

_____

_____

Stain 4

Indicate directionality of the stain by drawing an arrow parallel to the stain.

Support for determination of directionality:_____

_____

_____

_____

Stain 5

Indicate directionality of the stain by drawing an arrow parallel to the stain.

Support for determination of directionality:_____

Stain 6

Indicate directionality of the stain by drawing an arrow parallel to the stain.

Support for determination of directionality:_____

Post Lab Questions

1. Why does the size of blood drops resulting from impact to a blood source differ?
2. How do satellite stains and scallops differ?
3. Why is understanding the directionality of the stain important?
4. Why can't a single bloodstain be used for analysis?

13.2 Determining Angle of Impact

Objective

- Describe the method of measuring bloodstains.
- Practice calculating the angle of impact of bloodstains.

Concept Overview

Bloodstain pattern analysis is a scientific discipline in which blood and bloodstain pattern evidence is examined to determine the nature of the event(s) that created the evidence. The location of the bloodstain evidence is a critical element, as well as identifying the following characteristics of the bloodstains: size, shape, and distribution.

Bloodstain size is the result of an inverse relationship involving the amount of force applied to a blood source. The greater the amount of force applied, the smaller the bloodstains. For example, when a blood source is impacted by a projectile originating from the explosive force of a discharged firearm, the preponderance of the bloodstains in the resulting bloodstain pattern are approximately 1 mm or less in size. When a blood source is impacted with a bludgeoning instrument, such as a pipe or a bat, in motion from manual human force, the preponderance of the bloodstains in the resulting bloodstain pattern are 1–4 mm in size. Bloodstain size is a characteristic indicative of the nature of the force used in bloodletting events. It must be stressed, however, that a *single* bloodstain cannot be used to conduct an analysis of a scene. Bloodstain *patterns* are examined, and analysis is conducted within the context of the entire scene, not within a vacuum of bloodstain evidence only.

When bloodstains are in flight, they travel in a parabolic arc while under the influence of gravity and affected by their own mass. The heavier they are, the farther they will travel. Bloodstains travel upward until the peak of their parabolic arc is reached, and then they fall downward out of their arc until the bottom of the arc is reached. If bloodstains are allowed to travel in their arcs unimpeded, the resulting shape of the bloodstain upon landing will be circular. If a bloodstain strikes a surface while in flight, the shape of the stain will be the angle at which it was in flight upon impact. Thus, the geometry of a bloodstain defines its *angle of impact*. Resulting characteristics of a bloodstain after impact on a surface can also indicate the *directionality* of the bloodstain. These characteristics include:

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Distribution relates to bloodstain *patterns*, not solitary bloodstains. Examination of a bloodstain pattern may assist in determining the object that created the stains, a common area of convergence, or the location of the blood source upon forceful impact.

The single most limiting factor related to bloodstain pattern analysis is the surface texture on which bloodstains land and bloodstain patterns result. For example, with the variables of blood drop volume, distance fallen, and force applied to blood (gravity at 90 degrees), a bloodstain landing on a hard, smooth, nonporous surface would look very different from one landing on a rough, nonporous surface. The stain on the smooth surface would be circular in shape, while the stain on the rough surface would appear distorted and irregularly shaped.

After the ellipse area has been established (Figures 13.1 and 13.2), the width and length are measured.

These values are plugged into the formula below to calculate the angle of impact for the stain. This value will always be less than 1. (If the value is greater than 1, the formula was transposed [L/W] prior to calculation.)

1. Width/Length = N
2. Inverse sine of N = Impact angle

Example calculation:

$W = 1$

$L = 3$

a. $1/3 = 0.33$

b. Inverse sine of 0.33 = 19 degrees

Although the mathematics used to derive an angle of impact are precise, the variables that affect a blood drop in flight preclude such accuracy when determining the impact angle. Thus, a derived angle within a range of ±5 degrees of the true angle is considered accurate.

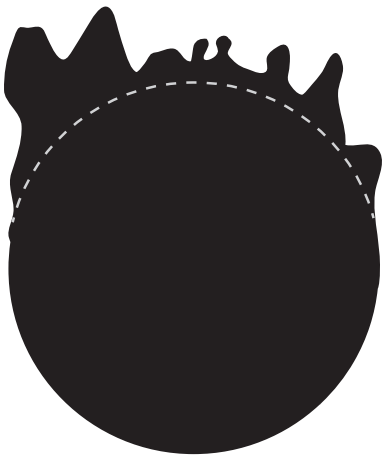

Figure 13.1
Ellipse of bloodstain, excluding scallops.

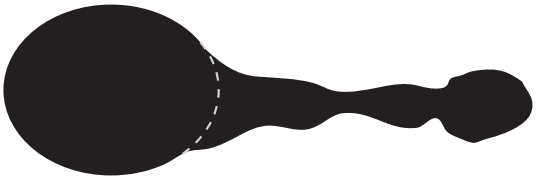

Figure 13.2
Ellipse of bloodstain, excluding tail.

Materials

- Writing utensil
- Scientific calculator

Procedure

1. The data table in the Evaluation Worksheet provides the width and length for designated bloodstains.
2. Using the provided formula and a scientific calculator, use the width and length values to calculate the angle of impact.
3. Complete the Evaluation Worksheet.
4. Complete Post Lab Questions.

Evaluation Worksheet

	Width (W)	Length (L)	W/L Value	Angle of Impact
Stain 1	1 mm	4 mm		
Stain 2	2 mm	3 mm		
Stain 3	1 mm	2 mm		
Stain 4	2 mm	6 mm		
Stain 5	4 mm	7 mm		
Stain 6	3 mm	4 mm		
Stain 7	4 mm	4.5 mm		
Stain 8	1.5 mm	4 mm		
Stain 9	3 mm	6.5 mm		
Stain 10	1 mm	1 mm		

1. Width/Length = N
2. Inverse sine of N = Impact angle

Post Lab Questions

1. What three characteristics should be noted in regard to bloodstains?
2. What is the parabolic arc in regard to blood evidence? Why is it important?
3. How accurate is the angle of impact?
4. Name three variables that could affect the interpretation of bloodstain patterns.
5. Why are scallops, satellite stains, and tails not included in the mathematical calculation?

13.3 Creation and Analysis of Impact Angles

Objective

- Create bloodstains with differing impact angles.
- Practice measuring bloodstains.
- Practice calculating the angle of impact of bloodstains.

Concept Overview

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Bloodstain size is the result of an inverse relationship involving the amount of force applied to a blood source. The greater the amount of force applied, the smaller the bloodstains. For example, when a blood source is impacted by a projectile originating from the explosive force of a discharged firearm, the preponderance of the bloodstains in the resulting bloodstain pattern are approximately 1 mm or less in size. When a blood source is impacted with a bludgeoning instrument, such as a pipe or a bat, in motion from manual human force, the preponderance of the bloodstains in the resulting bloodstain pattern are 1–4 mm in size. Bloodstain size is a characteristic indicative of the nature of the force used in bloodletting events. It must be stressed, however, that a *single* bloodstain cannot be used to conduct an analysis of a scene. Bloodstain *patterns* are examined, and analysis is conducted within the context of the entire scene, not within a vacuum of bloodstain evidence only.

When bloodstains are in flight, they travel in a parabolic arc while under the influence of gravity and affected by their own mass. The heavier they are, the farther they will travel. Bloodstains travel upward until the peak of their parabolic arc is reached, and then they fall downward out of their arc until the bottom of the arc is reached. If bloodstains are allowed to travel in their arcs unimpeded, the resulting shape of the bloodstain upon landing will be circular. If a bloodstain strikes a surface while in flight, the shape of the stain will be the angle at which it was in flight upon impact. Thus, the geometry of a bloodstain defines its *angle of impact*. Resulting characteristics of a bloodstain after impact on a surface can also indicate the *directionality* of the bloodstain. These characteristics include:

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Distribution relates to bloodstain *patterns*, not solitary bloodstains. Examination of a bloodstain pattern may assist in determining the object that created the stains, a common area of convergence, or the location of the blood source upon forceful impact.

The single most limiting factor related to bloodstain pattern analysis is the surface texture on which bloodstains land and bloodstain patterns result. For example, with the variables of blood drop volume, distance fallen, and force applied to blood (gravity at 90 degrees), a bloodstain landing on a hard, smooth, nonporous surface would look very different from one landing on a rough, nonporous surface. The stain on the smooth surface would be circular in shape, while the stain on the rough surface would appear distorted and irregularly shaped.

After the ellipse area has been established (Figures 13.1 and 13.2), the width and length are measured.

These values are plugged into the formula below to calculate the angle of impact for the stain. This value will always be less than 1. (If the value is greater than 1, the formula was transposed [L/W] prior to calculation.)

1. Width/Length = *N*
2. Inverse sine of *N* = Impact angle

Example calculation:

W = 1

L = 3

a. 1/3 = 0.33

b. Inverse sine of 0.33 = 19 degrees

Although the mathematics used to derive an angle of impact are precise, the variables that affect a blood drop in flight preclude such accuracy when determining the impact angle. Thus, a derived angle within a range of ±5 degrees of the true angle is considered accurate.

Materials

- Writing utensil
- Scientific calculator
- Clipboards
- Poster board
- Pipette
- Tape measure
- Metric ruler
- Blood
- Butcher paper (optional)

Procedure

To prepare for the exercise, butcher paper may be taped down with masking tape to protect the areas where the experiments will be conducted. If poster board is being used, it should be cut to properly fit onto the clipboards (approximately 8½ × 11 inches).

Prior to beginning the exercise, the group should label each sheet of paper/poster board with:

- Group member names
- Date
- Exercise title
- Grade of the substrate (level, gentle slope, steep slope)
- Height of the application (12, 24, 36, 48, or 60 inches)
  a. Determine the first substrate grade (level, gentle slope, steep slope).
  b. Secure a piece of copy paper/poster board onto the clipboard.
  c. Load blood from the container into the pipette.
  d. Drop four to six drops of blood on the paper from one of the predetermined heights (12, 24, 36, 48, or 60 inches), using a tape measure to ensure preciseness.
  e. Remove the exemplar from the clipboard and set it aside to dry.
  f. Repeat these steps for the remaining heights for this substrate grade.
  g. When all exemplars have been created for this substrate grade (5), continue on to another grade.

h. Continue on to create the exemplars for the last substrate grade. When complete, 15 exemplars will have been created.
i. Clean up the work area and prepare for measuring the bloodstains. A metric scale/ruler (preferably in millimeters), a scientific calculator, and the Data Worksheet are needed for this exercise.
j. Assemble the first set of exemplars created. Choose the best-formed bloodstain from each exemplar and circle it.
k. Use the Data Worksheet during the following. Use a metric scale to measure the width and length of the bloodstains chosen. Then, determine the *W/L* ratio and the angle of impact.
l. Repeat this process for the remaining two substrate grades.
m. Complete the Post Lab Questions.

Data Worksheet

	Height	Width	Length	W/L Ratio	Angle of Impact
Substrate Grade _____	12				
	24				
	36				
	48				
	60				
Substrate Grade _____	12				
	24				
	36				
	48				
	60				
Substrate Grade	12				
	24				
	36				
	48				
	60				

Post Lab Questions

1. In regard to the bloodstains created on a gentle slope, how did the angle of impact change as the height increased?
2. What information can be derived from bloodstains?
3. Can blood spatter alone solve a crime?
4. What is the formula for calculating angle of impact?

Optional Exercise

Unknown

Sample Number		Observations/Notes
Width/Length		
Width/Length ratio		
Angle ratio		

Based on the information obtained prior to calculating the unknown, what height and grade were the unknown samples dropped from? Give specific details to support this conclusion.

13.4 False-Positive Exercise

Objective

- Understand the concept of positive and negative controls.
- Describe a false positive.
- Utilize a chemical process to understand false positives.

Concept Overview

When conducting chemical tests, it is important to confirm whether the process is working correctly or not. Before using the chemicals on any evidentiary items, a positive and negative control should be used. A positive control is conducted with a known sample, such as blood from an individual. Using the chemical test on this sample should always yield a positive result. The failure to produce a positive result could be due to exhausted shelf life or improper preparation or storage of the chemical. A positive control ensures that the reagents used in the test are working properly and are safe to use on evidentiary samples. A negative control should also be used when the sample is on a medium. For example, when blood drops are found on dark, dyed blue jeans, a piece of the jeans, with no blood, should be tested to ensure that the dyes used in the material do not yield a positive result. The results of a negative control should always be negative. If a negative control is not used, and the dark, dyed jeans have a property that reacts with the chemical, a false positive may result. A false positive occurs when the chemical test reacts to a sample that does not contain the stain being tested. This could cause significant investigative issues, which may lead to wrongful prosecution and incarceration.

Materials

- Writing utensil
- Timing device

Procedure

1. Create a workstation using butcher paper or a similar material to cover the work area surface.
2. Gather the following materials for your workstation.
   - Writing utensil
   - Timing device
   - Hemastix
3. Using the yellow tip end of the Hemastix, touch the tip (pad) of the stick to the red substance provided.
4. Observe the pad for a maximum of 5 minutes.
5. Record the color change and the reaction time (time it took for the pad to turn colors).
6. Repeat this process for the same stain before moving forward. (Each stain should be tested twice to show concordance with the first result.)
7. Record all information in the Data Worksheet.
8. Once all samples have been tested, smell each stain and record what *you* believe the stain to be. Please note: Smelling stains should only be done in the context of an exercise that has been designed for smelling. This should *never* be done at a crime scene or during laboratory work.
9. Complete the Post Lab Questions.

Data Worksheet

Stain	Time	Color
1		
2		
3		
4		

Smell identification of samples:

1. _____
2. _____
3. _____
4. _____

Post Lab Questions

1. Did any of the samples provided create a false positive?
2. How many samples did you correctly identify by smell?
3. What is a positive control?
4. Why are negative controls important?

13.5 Presumptive Tests

Objectives

- Understand the concept of presumptive tests.
- Recognize a positive and negative presumptive test.
- Practice using various types of presumptive tests.

Concept Overview

Chemical presumptive tests are one way in which crime scene personnel can test a substance that is possibly blood. These tests rely heavily on chemicals that change color when they come into contact with the hemoglobin found in blood. To confirm that the chemicals are working properly, conducting positive and negative controls is crucial. A positive control is a sample that is known to react with the test chemical. For the purpose of this exercise, a known blood sample should be used to obtain a positive result (i.e., the proper color change) before continuing. A negative control is a known sample that is clean or void of any blood-based substrate and should yield no color change.

While these tests effectively record negative blood results, positive results do not always equate to human blood. False positives, substances that contain the same chemical properties as the substance being tested, may be generated by chemicals, or the blood present may be animal blood instead of human blood. Further testing is needed to confirm that the substance is human blood. There are several different types of presumptive tests that can be used.

A phenolphthalein test, also known as the Kastle-Meyer test, is commonly used in the field of forensic science. A reaction occurs when a bloodstain comes into contact with hydrogen peroxide, producing a color reaction. The test area generally progresses from clear to pink, indicating the substance could be blood.

Another chemical presumptive test is the tetramethylbenzidine (TMB) test. This is a catalytic test that is also based on peroxidase-like activity. Substances that come into contact with this chemical generally change from clear to a blue-green color when a positive reaction occurs.

O-Tolidine is also a presumptive test that can be used to test for the presence of hemoglobin. It works in the same way as the phenolphthalein test, except the phenolphthalein is replaced with an o-tolidine stock solution. Substances that come into contact with this chemical generally change from clear to a blue-green color when a positive reaction occurs.

Hemastix are small reagent test strips that were originally designed to detect trace amounts of blood in urine. The small yellow square on the end of the test strip serves as the chemical basis for the test. Again, based on peroxidase-like activity, the yellow test square will turn blue-green in the presence of strong samples, but smaller or weaker samples may yield a reddish-orange color.

Presumptive tests are beneficial in aiding crime scene personnel in determining which substances are potential blood evidence and should be collected for subsequent analysis.

Materials

- Writing utensil

Procedure

1. Each student will create a workstation by covering their work area with butcher paper or other protective covering.
2. Using the materials provided, create samples as explained by the instructor.
3. Test the samples using the presumptive tests provided.

4. **Warning!** Carefully follow the directions for each test as described by the manufacturer and/or your instructor.
5. Complete the Data Worksheet.
6. Complete the Post Lab Questions

Optional Exercise

1. Once the Data Worksheet has been completed, obtain an unknown sample from the instructor.
2. Test the unknown sample.
3. Complete the Data Worksheet for the unknown and complete any follow-up questions.

Data Worksheet

Presumptive test: _____

Sample	Reaction Time	Color Change	Observations

Presumptive test: _____

Sample	Reaction Time	Color Change	Observations

Presumptive test: _____

Sample	Reaction Time	Color Change	Observations

Presumptive test: _____

Sample	Reaction Time	Color Change	Observations

Post Lab Questions

1. Which method was easier to use? Why?
2. Why are presumptive tests important?
3. Define the following: false positive, positive control.
4. Based on the concept overview, complete the following worksheet.

Presumptive Test	Color Change
TMB	
Hemastix	
Phenolphthalein	
O-Tolidine	

Optional Exercise

Unknown

Sample Number		Observations/Notes
Presumptive test used		
Reaction time		
Color		

Based on the information obtained prior to testing the unknown, what is the unknown sample? Give specific details to support this conclusion.

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Taylor & Francis Group
http://taylorandfrancis.com

Chapter 14

Special Scene Considerations

Key Terms

Fire tetrahedron
Magnetometers
Ground-penetrating radar
Stratification

Learning Outcomes

1. Recognize the components of the fire tetrahedron.
2. Understand the challenges associated with fire scenes.
3. Understand intrusive versus nonintrusive methods used at a burial site recovery.
4. Recognize the challenges associated with a burial site recovery.

14.1 The Scientific Method in Fire Investigation

Kenneth Wilson, Fire Marshal, Azle, Texas

Objective

- Identify the organization that established the use of the scientific method in fire investigation.
- Explain the steps of the scientific method as they are used in fire investigation.

Concept Overview

Fire scene investigation is a complex task that can provide varying challenges. The approach to these investigations should be science based, and as such, the scientific method should be employed. The scientific method is an organized, systematic process by which the answer to a question is sought. While not verbally articulated, and in many cases intuitively and subconsciously carried out, the scientific method is utilized on a daily basis. In short, it is the trial-and-error method of decision making. The process begins with a problem to be solved or a decision to be made. Information is gathered about the issue, and a potential solution is developed (also known as a hypothesis). The proposed solution is tested. If the solution fails, the issue is reassessed with the information from the failed attempt incorporated, and a different solution is formed. This process is repeated until the issue is solved.

The National Fire Protection Association (NFPA), a global organization that establishes codes and standards for fire professionals, has established the steps by which the scientific method will be carried out in fire investigations:

- Recognize the need
- Define the problem
- Collect data
- Analyze the data
- Develop the hypothesis
- Test the hypothesis
- Select a final hypothesis

By following this process, the investigator is able to conduct an organized investigation and develop multiple hypotheses. They are tested until one is developed that solves the issue/resolves the question. This investigative method prevents an inaccurate conclusion as to the determination of the fire cause.

Materials

- Writing utensil
- Copy of NFPA 921, Chapter 4: Basic Methodology

Procedure

1. Review NFPA 921, Chapter 4: Basic Methodology.
2. Using the following table, list the seven steps of the scientific method as outlined by the NFPA for use in fire investigation.
3. In the table, define each step of the scientific method as it is employed in fire investigation.

Evaluation Worksheet

Investigative Step	Investigative Step Defined
Recognize the need	
Define the problem	
Collect data	
Analyze the data	
Develop hypothesis	
Test hypothesis	
Select final hypothesis	

Post Lab Questions

1. How does the scientific method prevent inaccurate conclusions?
2. After collecting the data, which step should the investigator perform next?
3. When testing a hypothesis, should the investigator attempt to prove or disprove the hypothesis?

14.2 The Value of Fire Patterns and Fire Signs

Kenneth Wilson, Fire Marshal, Azle, Texas

Objective

- Examine photographs and identify fire patterns and indicators of arson.

Concept Overview

Fire scene investigations are complex and require the implementation of an organized and systematic process to reach successful outcomes. The first goal of these investigations is to identify the origin of the fire. Once this is accomplished, the task becomes finding the cause of the fire.

Fire scenes are literally scenes of destruction. The fire has obviously caused destruction, and fire suppression efforts have created destructive consequences through forced building entry, breaking of windows, and removal of walls. Artifacts such as these can create difficulty when searching for fire signs.

Fire patterns are evidence left behind at the fire scene. They show the progress of the fire, indicate the type of fuel(s) involved, and assist in locating the origin of the fire. Fire patterns, which are classified as either movement (fire spread) or intensity (heat), are the basis for fire investigation and must be correctly interpreted by the investigator in order to reach the correct conclusion. Fire pattern analysis is the process used by the investigator to examine the evidence and determine how the fire created each pattern. The correct interpretation of the fire patterns can lead the investigator to the origin of the fire and result in determining the cause.

Common fire patterns and fire signs are:

- Char pattern—Typically results from direct flame. It can indicate the amount of time the surface burned as well as the direction the fire moved.
- Smoke—An airborne particulate product of incomplete combustion. The smoke deposit is brown in color.
- Soot—Black particles of carbon produced in a flame. The soot deposit is black.
- Trailer—Manner by which an ignition point is extended.
- Circular burn pattern—Occurs when an area is protected from burning by a circular item.
- V-pattern—Created when flame rises on a wall.
- Donut pattern—Results when accelerants have deeper char at the edges than in the center.
- Saddleburn—U-shaped burn pattern with deep charring on the top of floor joists, caused by fire burning down through the floor. Often caused by a burning liquid on the floor or radiant heat from a material close to the floor.
- Directional melting—Damage pattern typically found in glass and plastic items. Melting occurs in the direction of the approaching heat source.

Utilizing the information provided by firefighters, witnesses, and scene observations to determine the origin of a fire and to make a determination of the cause of the fire is integral to the investigation. Prior to classifying a fire as incendiary (arson), the investigator has to articulate the results of the fire pattern analysis and rule out possible accidental causes of ignition. Knowing how fire patterns are created through the intensity of fire development and movement of hot gases will aid the investigator in correctly identifying the origin of the fire. The correct origin of the fire has to be determined in order to identify the cause.

Materials

- Writing materials
- Photographs

Procedure

1. Examine the photographs provided and identify the various movement patterns.
2. Examine the photographs provided and identify the various intensity patterns.
3. Examine the photographs provided and identify indicators of an incendiary (arson) fire.

Post Lab Questions

1. What effect does fire suppression have on fire patterns?
2. Explain the different movement patterns that were observed in the photographs.
3. Explain the different intensity patterns that were observed in the photographs.
4. Explain the indicators of an incendiary fire and how they are created.

14.3 Burial Recovery

Objective

- Describe nonintrusive methods of locating graves.
- Describe intrusive methods of locating graves.
- Practice recovering buried remains.

Concept Overview

Burial recovery sites are challenging crime scenes to work due to the victim being buried in various types of soil and/or exposed to the environment for an extended period of time. Generally, law enforcement is presented with a burial site in one of two ways. The first way involves a citizen notifying police of the grave. For example, a man was out walking his dog and stumbles upon a shoe sticking out of the ground, so he goes home and notifies the police. The second way involves law enforcement actively looking for a grave. This is often the case when a crime scene is discovered with no body/victim present. Suggestions at the scene lead law enforcement to believe that there is a secondary scene, which leads them to search a specific area to locate the body.

When searching for a burial site, a number of nonintrusive methods may be employed. The first, and least invasive, is a visual search. A variety of factors may affect what a searcher may see, including disturbed soil/dirt, vegetation that has been disturbed or is redeveloping, and/or an abnormality in the soil/dirt. This abnormality can be seen as a high mound of soil when no others are present or as a deep depression in the soil when the elevation is consistent. Other nonintrusive methods include magnometers, ground-penetrating radar (GPR), and infrared thermography. Magnometers detect abnormalities in the surface's magnetic field. Metallic items are easily identified using this technique. GPR sends a low-frequency signal into the ground, which is returned in a specific way according to the conditions encountered below the surface. Infrared thermography works using the heat signatures of the soil. Differences between soil in the surrounding area and the soil close to or at the site may help deduce where the burial site is located.

While nonintrusive methods are preferred, it is sometimes necessary to utilize intrusive methods, which include the use of probes and vapor monitors. Probes are used to detect the different densities within the soil. Generally, teams are composed and the area is searched using standard searching techniques. Any detection of abnormality should be noted and further explored by the team leader. Vapor monitors are used to detect the gases associated with decomposition. Typically, the vapor monitors are used in conjunction with another technique such as probing.

Once a site has been discovered, the surface debris should be removed. These items/areas can be excavated independent of the burial site. Once documented, loose debris should be removed from the scene and evaluated for evidentiary significance. Ground plants should be removed by cutting them at the surface. Careful consideration must be taken to avoid disturbing other layers of soil, so plants should never be pulled out of the ground. Screens are used to filter all soil removed from the site. This could help locate small items of interest such as small bones, teeth, and bullets. The actual excavation is conducted in levels, just as an archeological site would be. Each layer, or stratification, is removed evenly across the site, approximately 2 inches at a time, before proceeding deeper into the grave. Each artifact located is in the reverse order of deposit into the grave. Shoveling soil arbitrarily from the grave will result in the loss of stratum where the evidence/object was located. This can make reconstruction of the scene difficult or impossible. As new artifacts are exposed, they should be carefully documented and mapped on the overlying grid. Initial exposure of the body is the apex of the search; however, protocol should not be put by the wayside. Digging within the stratification should continue as normal until the entire body is exposed. Once the body has been documented, it can be removed from the grave by the proper personnel. While this seems a natural end, searchers should continue to excavate below the body for additional artifacts and evidentiary items that may prove valuable to the case.

The recovery of burial sites is a tedious and time-consuming process. To conduct a recovery in haste could be detrimental to an investigation.

Materials

- Writing utensil
- Digital camera, if burial is to be documented through photography
- Scale of reference, if burial is to be documented through photography
- Tripod, if burial is to be documented through photography
- Photography log, if burial is to be documented through photography

Procedure

1. Confirm the members of your excavation team and the role/task of each member. The duties in this exercise include:
   - Creating field notes
   - Excavating
   - Sifting removed soil
   - Collecting measurements for plotting evidence
   - Creating sketches
   - Documenting with photography (if desired by the instructor)
2. Create a workstation by placing butcher paper over your work surface area.
3. Examine the burial site and begin a field note document. This document should contain:
   - Observations of the site
   - Description of the site
   - Recovered items, time of recovery

4. Use a measuring tape to determine the dimensions of the site, including the depth.
5. Excavate the site by removing one spoonful of dirt at a time and transferring it into a provided container. The removed dirt should be sifted for item recovery. Dirt removal should be the same depth across the entire site before continuing on to deeper depths.
6. If an item is revealed, plot the item using the grid/triangulation or rectangular coordinates on a grid method. These measurements will be used to create a projection sketch of the burial site. Also, record the depth of the recovered items; these measurements will be used to create an elevation sketch. (Choose one system of measurement for data collection.)
7. Use the provided mapping measurement records to record measurements.
8. Use the provided sketch canvases to sketch a projection view and elevation sketch of the burial site.
9. Create a finished projection sketch of the burial site depicting the recovered items, if desired by the instructor.
10. Create a finished elevation sketch of the burial site depicting the recovered items, if desired by the instructor.
11. Complete the Post Lab Questions.

Mapping Measurement Record: Grid/Triangulation						
Sketch artist:		**Date:**				
Location:						
Object or Placard No.	**Object**	**RP-1**	**RP-2**	**RP-3**	**RP-4**	**Depth**

Mapping Measurement Record: Grid/Rectangular Coordinates				
Sketch artist:		**Date:**		
Location:				
Object or Placard No.	**Object**	***x* Measurement**	***y* Measurement**	**Depth**

Sketch Canvas

Sketch Canvas

Sketch Canvas

Sketch Canvas

Post Lab Questions

1. Describe two ways in which a burial site may be found.
2. Name two nonintrusive techniques that can be used at a burial site.
3. Name two intrusive techniques that can be used at a burial site.
4. Why is it important to cut plants or other vegetation at the surface of the grave?
5. Why is it important to keep digging once the body has been removed?

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Chapter 15

The Body as a Crime Scene

Key Terms

Rigor mortis
Algor mortis
Livor mortis
Decomposition
Entomology
In situ
Asphyxial trauma
Sharp force trauma
Blunt force trauma
Gunshot trauma

Learning Outcomes

1. Discuss the causes and manners of death.
2. Identify the stages of decomposition.
3. Identify and properly document entomological activity.
4. Recognize the basic mechanisms of injury.

15.1 The Body

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Objective

- Understand how the body is a significant source of physical evidence.
- Discuss the causes and manners of death.
- Recognize early postmortem indicators.
- Identify various types of trauma that may be present on the body.

Concept Overview

The body can be a significant source of physical evidence. Whether the victim is alive or deceased, the body is essentially a crime scene within a crime scene. In cases of death, it is important to establish the cause and manner of death. The cause of death is why the cessation of life occurred. The manner of death is, generally, listed as one of the following four manners: homicide, suicide, natural causes, and accidental. Some states will also record an undetermined or equivocal death if after assessment the manner cannot be determined.

The determination of the postmortem interval (PMI), time since death, is central to most investigations involving decedents. Early postmortem indicators are the presence of livor mortis, rigor mortis, and algor mortis.

- *Livor mortis* is the settling of the blood in the body after circulation ceases. It is observed by assessing light red to dark purple coloration on the body in as little as 30 minutes after death. Most references suggest that livor mortis is "fixed" after 8 hours; however, there are variables that may adjust this time frame.
- *Rigor mortis* is the stiffening of the muscles after death. It affects all muscles in the body, but it is observed at different rates (smaller muscles typically stiffen first, with larger muscles following). The time frame for rigor mortis is as follows:
  - 2–4 hours after death: Muscles begin to stiffen.
  - 8–12 hours after death: All muscles are stiff from head to toe.
  - 18–36 hours after death: Stiffening begins to disappear.
  - 48–60 hours after death: All signs of rigor mortis will be gone.

  The time frames listed above are highly variable based on the environmental conditions, clothing on the body or lack thereof, and the decedent's level of activity before death.
- *Algor mortis* is the cooling of the body/loss of heat after death. Under moderate conditions, an adequately clothed adult will cool 1 degree every hour. The temperature of the body is usually determined by taking a core reading. This is done by taking a temperature reading from the liver. This action is usually done by the medical examiner or death investigator, as a small incision is made near the liver and a thermometer inserted into the body. The ambient temperature of the scene should also be recorded as body temperature is highly variable. Most references suggest that algor mortis will not be assessed after 12 hours, as degradation of the body has progressed to a point where the temperature is not a good assessment of postmortem interval.

Decomposition involves the putrefaction of the tissue due to bacteria. It usually manifests itself first as a blue/green discoloration in the abdomen area of the body. Other indicators include swelling of the tissue in the body and protrusion of the eyes and/or tongue. As blood vessels begin to break down, a marbling effect may be visible on the skin. Fluids may also be purged from the mouth and other openings in the body, and skin slippage will also begin to occur. Decomposition rates vary greatly as heat will speed up the process while colder environments will slow it down.

Injury assessment may also be an important component when evaluating the body. The primary mechanisms of injury that are generally of interest to crime scene personnel are:

Asphyxial trauma: The inability of the body to take in oxygen or eliminate carbon dioxide. Examples of this include, but are not limited to, strangulation, choking, smothering, positional/mechanical asphyxia, and chemical asphyxia.

Sharp force trauma: Physical cutting of the skin. There are generally two forms:

- Incised wound: Generally longer than it is deep and produces a significant amount of blood loss.
- Stab wound: Generally deeper than it is long. The type of weapon used (shape and size of the edged weapon) will determine the amount of internal damage. There is usually bruising and/or other markings on the skin at the incision point.

Blunt force trauma: Injury that is produced by damaging the skin. There are typically three types of blunt force injuries:

- Abrasions: Reddish-brown in color with little to no significant tearing of the skin.
- Contusions: Commonly noted as bruises, contusions are present just below the skin surface. They can appear on the skin in a variety of colors, from red to blue/black.
- Lacerations: The physical tearing of the skin. A laceration is characterized by open, irregularly shaped trauma to the body with tissue bridging between the sides of the defect.

Gunshot trauma: Injury that is the result of a firearm. These are typically classified as:

- Penetrating: The projectile(s) enters the body but does not exit.
- Perforating: The projectile(s) enters and exits the body.
- Grazing: The projectile(s) strikes parallel to the skin, thus leaving an abrasion.
- Tangential: The projectile(s) "skips" across the skin, leaving a series of shallow wounds across the skin.

When assessing gunshot wounds that are penetrating or perforating, it is important to evaluate the range at which the weapon was fired. When describing range determinations, the following terms are typically used:

- Contact: The muzzle of the weapon is pressed against the victim's body. Due to the discharge of gases and the explosion of the ammunition, there will be a forced opening at the point of contact. This is characterized by the radiating star-like pattern (stellate) that will occur when the projectile is fired against hard bone.
- Close contact: The weapons is held close enough to the body for the heat to affect the skin. This can be visualized as there will be blackened, seared skin around the wound and/or on the clothing covering the wound. The powder particles may also be present on the skin, causing a "tattooing" or stippling pattern to occur.
- Intermediate: The muzzle of the weapon is held far enough away from the body that heat and soot effects will not be present, but still close enough for the heated powder particles to cause stippling on the skin.
- Indeterminate and/or distant: No heat, soot, or stippling characteristics will be present on the body.

Materials

- Writing utensil

Procedure (Part 1: Investigative Report)

1. Review the provided scene photographs.
2. From the perspective of a medicolegal death investigator, write a descriptive investigative report. Conclude the report with a statement indicating a cause and manner of death.

Procedure (Part 2: Evidence Collection)

1. Examine the provided scene photographs.
2. For each scene photograph, identify an item of evidence that you would collect as well as its investigative purpose or significance. Record this information in the table provided.

Item of Evidence Collected	Purpose/Investigative Significance
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

Procedure (Part 3: Postmortem Assessment)

1. For each time interval listed in the following table, think about what type of postmortem changes you would expect to see.
2. Record your anticipated observations in the table.

Time Interval	Observations
1. 2–4 hours	
2. 8–12 hours	
3. 24–48 hours	

Procedure (Part 4: Identifying Trauma to the Body)

1. Examine the provided scene photographs.
2. For each photograph, determine the type of trauma that is present and support your conclusion.
3. Record the trauma type and the observations that support your determination in the following table.
4. Complete the Post Lab Questions.

Photograph No.	Trauma	Justification

Post Lab Questions

1. Define the following types of trauma:
   a. Asphyxia related
   b. Sharp force
   c. Blunt force
   d. Gunshot wound
2. Describe the key differences between sharp force and blunt force trauma.
3. Define each postmortem change:
   a. Algor mortis
   b. Livor mortis
   c. Rigor mortis
4. Within what time frame does each postmortem change typically initiate for a deceased person?

15.2 Entomology

Objective

- Describe the purpose of assessing entomology within a crime scene.
- Practice recognizing, documenting, and collecting entomological evidence.

Concept Overview

Entomological activity is commonly found in cases where decomposition is observed. Entomology involves the study of insects/arthropods and, specifically in relation to decedents, the number of life cycles for a variety of insects present in the decomposing tissue. The life cycles of the insects can help to determine the postmortem interval and aid in estimating the time since death. Insects are attracted to graves/decomposing remains for a variety of reasons. Some species are attracted to decaying flesh (carrion); predator species feed on other insects; omnivorous insects are attracted to food sources in general.

The life cycle of insects can be predictable and thus a good source for aiding in the determination of time since death (Figure 15.1). Several species of blowflies are attracted to bodies during the initial stages of decomposition. Adult flies lay their eggs on the corpse, and the eggs hatch and grow through various stages of larval development. After their final feeding stage, the larvae change to pupae. The pupae eventually give way to adult flies, and the life cycle starts again. While flies are generally the first insects to appear at a corpse, beetles and other insects such as ants and wasps can also be found. They generally appear once the odor of the corpse has become strong enough to attract the insects.

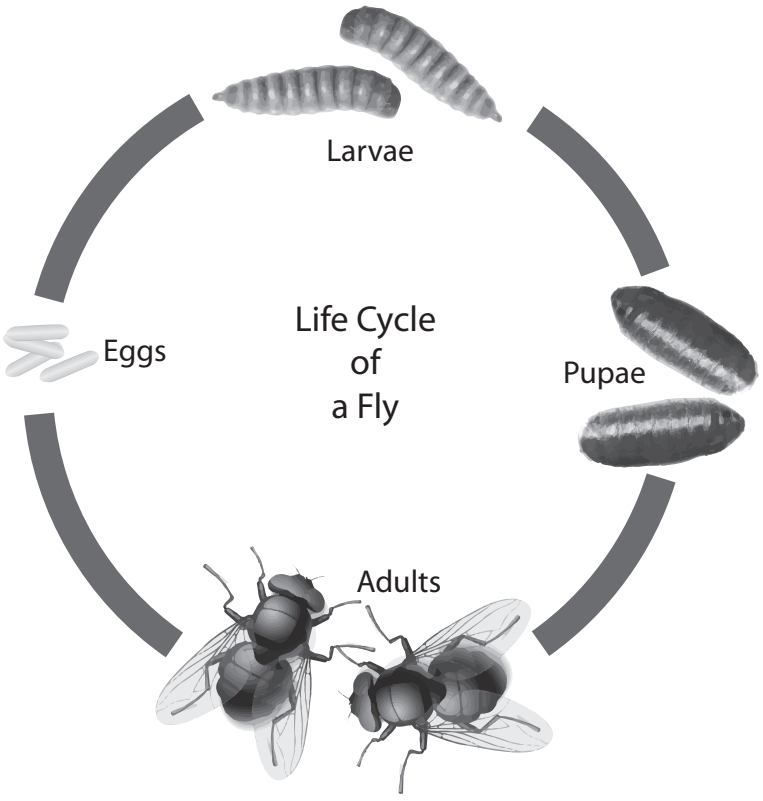

Figure 15.1
Blowfly life cycle.

Forensic entomologists can estimate a postmortem interval by assessing:

- Life stages of flies present on the corpse
- The amount of insects found on or around the corpse
- The presence of other insects

In order for the insects/arthropods to be used for forensic purposes, specimens need to be collected for evaluation by a forensic entomologist. If possible, the entomologist should come to the scene to observe the insects/arthropods within the crime scene. If the entomologist is unavailable, the specimens should be collected quickly, as once the body is moved, the insects/arthropods will relocate.

Scene documentation: The scene documentation should include the environmental conditions, such as a description of the terrain; weather conditions, such as precipitation; and temperature or range of temperatures at the time of collection.

Decedent information: Details regarding the position of the decedent, exposure of the body to the sun or shade, the state of decomposition, and if the body is in proximity to water should be noted for the entomologist. If any other details can be noted, such as sex and clothing, include them as well.

Collection of specimen: During any type of collection, proper personal protective equipment (PPE) should be worn. If applicable, insect samples should be collected for analysis; live specimens should be maintained, and some should be preserved.

Live Samples

- Recommended number: This varies based on the source and laboratory/entomologist evaluating the samples. It is best to check with them prior to collection. Usually, 20–30 are sufficient unless it is requested that more be collected.
- Documentation: Photographs are an important step in the documentation of the crime scene as a whole, as well as documenting the entomological activity. Each specimen should have the life cycle stage noted (larva, pupa, adult, etc.), where it was collected (the specific part of the body/ground), the time and date of collection, and the approximate ambient temperature.
- Collection: A variety of forceps, spoons, and nets can be used to collect the specimens. Each specimen should be carefully placed in a ventilated jar or other container with a food source in order to keep the samples alive.

Preserved Samples

- Recommended number: This varies based on the source and laboratory/entomologist evaluating the samples. It is best to check with them prior to collection. Usually, 20–30 are sufficient unless it is requested that more be collected.
- Documentation: Photographs are an important step in the documentation of the crime scene as a whole, as well as documenting the entomological activity. Each specimen should have the life cycle stage noted (larva, pupa, adult, etc.), where it was collected (the specific part of the body/ground), the time and date of collection, and the approximate ambient temperature.
- Collection: A variety of forceps, spoons, and nets can be used to collect the specimens. Each specimen should be either placed directly into 80% (or greater) ethyl alcohol or anesthetized using an insect kill jar and then placed into 80% (or greater) ethyl alcohol, or placed into labeled ziplock bags and kept frozen until they are sent to the laboratory for analysis.

Materials

- Writing utensil

Procedure

1. Review the crime scene scenario and the insects/arthropods to determine the type of insects/arthropods present.
2. In the Data Worksheet, describe the types of insects that may be/are present and provide support for the answers.
3. If applicable, collect the insects/arthropods as described in the Concept Overview and submit for instructor review.
4. Complete the Post Lab Questions.

Agency:	Case no.:	Type of offense:
Specimens collected by:		
Descendent information:		
Scene description information:		

Data Worksheet

Sample no.:	**Life Stage**	**Date of collection:**
Location from where the specimen was taken:	☐ Egg	
	☐ Pupae	**Time of collection:**
	☐ Larva	
	☐ Adult	
	Collection Method	**Collection**
Type of insect/arthropod collected:	☐ Net	☐ Live
	☐ Forceps/tweezers	☐ Preserved
	☐ Hands	**Cold Storage**
	☐ Other; explain	☐ Yes
		☐ No
Justification/additional information:		
Instructor Only		
☐ Type of insect/arthropod	☐ Life stage	☐ Collection method
Comments:		

Sample no.:	**Life Stage**	**Date of collection:**
Location from where the specimen was taken:	☐ Egg	
	☐ Pupae	**Time of collection:**
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Justification/additional information:		
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Justification/additional information:		
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		☐ No
Justification/additional information:		
Instructor Only		
☐ Type of Insect/arthropod	☐ Life stage	☐ Collection method
Comments:		

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Comments:		

Sample no.:	**Life Stage**	**Date of collection:**
Location from where the specimen was taken:	☐ Egg	
	☐ Pupae	**Time of collection:**
	☐ Larva	
	☐ Adult	
	Collection Method	**Collection**
Type of insect/arthropod collected:	☐ Net	☐ Live
	☐ Forceps/tweezers	☐ Preserved
	☐ Hands	**Cold Storage**
	☐ Other; explain	☐ Yes
		☐ No
Justification/additional information:		
Instructor Only		
☐ Type of insect/arthropod	☐ Life stage	☐ Collection method
Comments:		

Sample no.:	**Life Stage**	**Date of collection:**
Location from where the specimen was taken:	☐ Egg	
	☐ Pupae	**Time of collection:**
	☐ Larva	
	☐ Adult	
	Collection Method	**Collection**
Type of insect/arthropod collected:	☐ Net	☐ Live
	☐ Forceps/tweezers	☐ Preserved
	☐ Hands	**Cold Storage**
	☐ Other; explain	☐ Yes
		☐ No
Justification/additional information:		
Instructor Only		
☐ Type of insect/arthropod	☐ Life stage	☐ Collection method
Comments:		

Sample no.:	**Life Stage**	**Date of collection:**
Location from where the specimen was taken:	☐ Egg	
	☐ Pupae	**Time of collection:**
	☐ Larva	
	☐ Adult	
	Collection Method	**Collection**
Type of insect/arthropod collected:	☐ Net	☐ Live
	☐ Forceps/tweezers	☐ Preserved
	☐ Hands	**Cold Storage**
	☐ Other; explain	☐ Yes
		☐ No
Justification/additional information:		
Instructor Only		
☐ Type of insect/arthropod	☐ Life stage	☐ Collection method
Comments:		

Post Lab Questions

1. What is entomology?
2. Why is it important in death investigations?
3. Describe the fly life cycle.
4. What information is needed when documenting the collection of an insect?

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Chapter 16

The Role of Crime Scene Analysis and Reconstruction

Key Terms

Literature review
Scientific method
Hypothesis
Event analysis
Event segments
Absolute chronology
Relative chronology
Terminus ante quem
Terminus post quem
Terminus peri quem
Flowchart

Learning Outcomes

1. Understand the importance of journal articles.
2. Define scientific method.
3. Review and implement the components of an experimental design.

16.1 Journal Article Review

Objective

- Increase technical vocabulary related to forensic science.
- Learn how to concisely summarize a journal article containing scientific and detailed information.
- Increase scientific knowledge base.
- Enhance critical thinking skills.

Concept Overview

Journal articles are periodicals that contain written documents pertaining to a specific subject matter. It is critical to read journal articles to keep up with new and advancing technologies within specific fields, especially forensic science.

A journal article is generally divided into several sections: abstract, introduction, materials and methods, results and discussion, and conclusion. The abstract is generally a 200- to 600-word short description of the paper that has been written. It is a quick reference for the reader containing keywords and a few sentences regarding the overall concept. The introduction expands on the abstract and may cover background information (i.e., previous studies) or describe the novelty of the project. It may also contain a historical perspective on specific scientific techniques being used. The materials and methods section describes the items used in the experiment and the methods used to obtain data. The results and discussion section depicts data that have been generated, either positive or negative, and dialogue regarding their success or shortcomings. The conclusion gives an overall summary to the work being presented and possibly outlines future research or implications regarding the data or techniques used.

In regard to forensic science, a number of journals exist to keep crime scene technicians and scientists up to date. Examples of the journals are as follows: *Journal of Forensic Science*, *Forensic Science International*, *Journal of Forensic Identification*, and the *Lone Star Forensic Journal*.

Materials

- Writing utensil

Procedure

1. Search for a forensic science journal article to review. During the review, do the following in the Evaluation Worksheet:
   - Identify three terms with which you are unfamiliar. For each term, describe/define each and articulate how they are related to, or used in, the forensic science field.
   - Write a brief summary of each section of the article. Each section should be summarized in three or four sentences.
2. Prepare a paper for submission to your instructor.
3. Complete the Post Lab Questions.

Evaluation Worksheet

Term	Definition

Section	Summary
Introduction	
Materials and Methods	
Results and Discussion	
Conclusion	

Post Lab Questions

1. Did you find the article interesting? Why or why not?
2. Was the article difficult to summarize? Why or why not?
3. List three things learned from reading the article.
4. Describe how reading the article could benefit you as a crime scene technician and/or forensic scientist.
5. Explain how the author could expand the article to be more beneficial or informative.

16.2 The Scientific Method

Objective

- Learn the components of the scientific method.
- Design an experiment using the scientific method.

Concept Overview

Science is the understanding of the structure and behavior of the physical and natural world through systematic study, examination, and testing. The actual process of science, known as the scientific method, involves taking an unknown event and proposing various plausible explanations for the event. Conclusions are drawn based on the data collected

from experiments conducted to prove or disprove specific questions regarding the plausible explanations. These questions are formed into hypotheses, or neutral statements, which can be either proven or disproven.

In forming questions regarding scientific events, there are two characteristics that must be addressed. The first is that the questions that are asked must be *testable*. It is not scientific to ask, "How many leprechauns are at the end of a rainbow?" because a test cannot be created to answer the question. The second is *repeatability*. Science is a public venture and data are generally published for other scientists to review. It is important that other scientists in the field are able to replicate your work and gain comparable results. If only you can make a particular experiment work, it is not science.

After the hypothesis has been formed, it is necessary to generate data. The data must be carefully analyzed to either prove or disprove the hypothesis. This is known as the probative value.

When preparing an experiment using the scientific method, several areas should be addressed.

1. Title of the project: The title should address the focus of the project.
2. Defined problem or question: This is the overall objective of the research—what is to be proven and why.
3. Data collection: Identify what data need to be collected and the most beneficial method of collection, based on the research being conducted. This should include a literature review of all articles relevant to the project. Upon reviewing the data, it is important to determine whether the project has been done before and what makes this project unique.
4. Working hypothesis: This is the specific question(s) addressed within the project and the related testable expectation(s). These should be written as statements that can be proven or disproven.
5. Classification and organization of data: Data should be classified and organized logically and in a manner that facilitates experimentation. This area should also address the storage and disposal of data (i.e., biological samples), should it be necessary for the project.
6. Test of hypothesis: This explains the specific process or mechanism by which the hypothesis is to be tested.
7. Conclusion: This is a short summary describing why the research is important and who it will benefit, and it contains literature points that support the statements made.

The scientific method has been used for many years. Undoubtedly, the proof or disproof of a hypothesis leads to more hypotheses formed and more research and scientific data analysis conducted. Therefore, many people view this as a circular process, without which new advances and techniques could not be developed.

Materials

- Writing utensil

Procedure

1. Select a topic for research.
2. Complete the Evaluation Worksheet.
3. Complete the Post Lab Questions.

Evaluation Worksheet

Title of the project:	Question/Problem
Collection of experimental data (method of collection, number of samples, etc.)	Literature review references 1. 2. 3.
Working hypothesis (statement that can be proven or disproven)	Data organization (dissemination of data, storage, disposal, etc.)
How will the hypothesis be tested? (evaluation standards, such as data with an error rate of less than 5%)	Conclusion summary points 1. Why is the project important? 2. How is this project beneficial to the field? 3. Possible other projects/literature points to support statements

Post Lab Questions

1. Was it difficult to find a topic of interest to you? What were some of the specific difficulties?
2. Why is the scientific method important?
3. Why is it important for your data to be reproducible for other scientists?
4. How is preparing an experimental scientific method beneficial?
5. Why is it important to stay current on topics, technologies, and techniques pertinent to the field of forensic science?

16.3 Flowcharting Event Segments

Objective

- Describe event analysis.
- Describe how the chronology of event segments is defined.
- Explain why graphic representations of crime scene reconstruction are valuable.
- Practice flowcharting event segments of an incident.

Concept Overview

Crime scene reconstruction is the culmination of all previous activities. Its purpose is to try to establish the order or sequence of events that led to the incident. The incident is defined as the overall situation being investigated. Each event is a macrocomponent of the overall incident. The ability to reconstruct these individual events is vital to closing an investigation. In order to reconstruct a crime scene, a number of steps should be taken and are as follows:

1. Collect data and establish likely events.

   Collection begins at scene arrival. Information is collected from the time the crime scene personnel first enter the scene until the time they finish processing and debrief.
2. Establish event segments from the data available.

   By reviewing and considering all the information collected at the scene, crime scene personnel begin to define specific aspects of the incident.
3. Define associated event segments.

   When these aspects are realized, event segments will emerge. It is then important to associate specific actions. A review should be conducted of all actions to ensure an that important event has not been missed.
4. Order and sequence the associated event segments.

   Once the event segments have been identified, the order and sequence of the segments must be established. Relative chronology articulates only the event segments in relation to one another. It identifies what precedes or follows a given set of actions and does not speak to absolute time. Segments are sequenced using the following terms.
   - Terminus ante quem: Event segments that have preceded another event segment
   - Terminus peri quem: Event segments that were likely simultaneous
   - Terminus post quem: Event segments that have followed another event segment
5. Review the information.

   From beginning to end, the information used to form the event segments and consecutive sequencing must be checked and confirmed. Contradictory evidence may result in multiple crime scene reconstruction scenarios.
6. Determine the order of events.

   A certain level of assumption must be made in order to begin the reconstruction process. Once all the facts have been reviewed, a relatively clear picture of the events should emerge. The addition or consideration of new events or data, in regard to the scene, may help to better define the sequence or eliminate data from the chart.

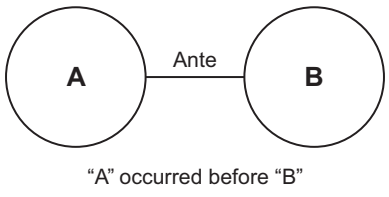

Figure 16.1
Terminus ante quem.

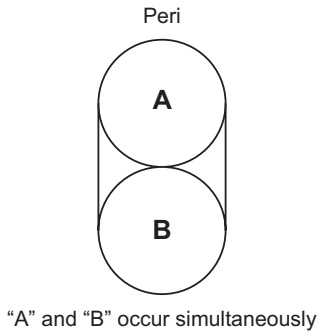

Figure 16.2
Terminus peri quem.

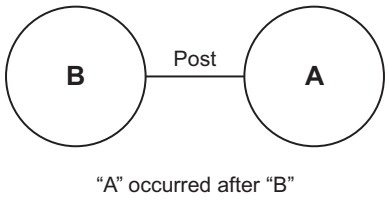

Figure 16.3
Terminus post quem.

7. Create a flowchart of the overall incident.

   The incident is now in the form of specific actions, ordered and sequenced as efficiently as the data from the scene will allow. In order to make the events visually clear to understand, either to other law enforcement personnel or to lay members of the court, a flowchart should be constructed. This allows persons to easily see the event segments that culminated in the incident.

As an example of the process, read the following passage, examine Table 16.1, and then see Flowchart 1.

> A woman purchased rosebushes to plant alongside her house. The woman's dog could see her and the newly purchased bushes through the slats of the backyard fence. The dog barked and jumped wildly in excitement. Fearing her dog would damage the new roses, the woman did not allow her dog to leave the fenced backyard. After planting the bushes, the woman went inside her house. Shortly thereafter, a strong wind began to blow. Later in the afternoon, the woman returned outside to admire her new roses. She found several holes in the ground where she had planted the bushes. The door of her backyard fence was standing open. Walking through the fence door into the backyard, she saw mangled bushes on the ground, and her dog had a muddy snout and paws. As he walked toward her, she could see rose petals caught in his collar.

TABLE 16.1
Scene Order of Events

Scene	Action	Sequence No.	Relative Chronology
Flower bed/exterior house	Flower bush planted	1	Ante quem
	Plants destroyed	3	Post quem
Backyard	Dog gets out of backyard/open gate	2	Peri quem
	Mangled flowers found/dog has muddy paws and snout	4	Post quem
Environment	Strong wind blows	2	Peri quem

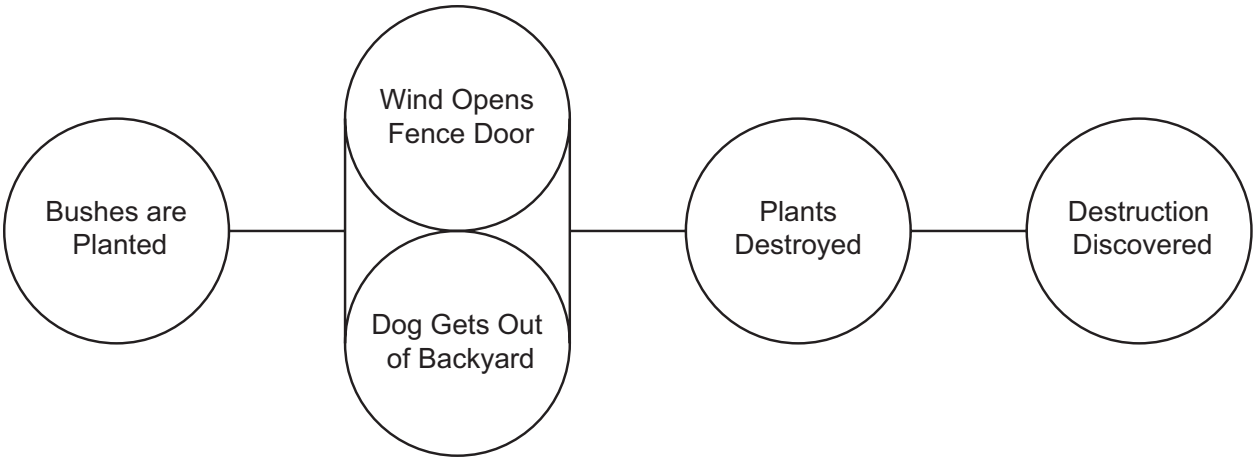

Figure 16.4
Flowchart 1.

Materials

- Writing utensil

Procedure

1. Read the "Report of Events."
2. Analyze the report and complete the Data Worksheet identifying the event segments or specific actions.
3. Complete the flowchart.
4. Make a list of the identified event segments.
5. Fill in the provided flowchart in a logical, relative chronology.
6. Complete the Post Lab Questions.

Evaluation Worksheet

Report of Events

A homeowner returned home to find her residence had been broken into. Responding investigators found that the south door of the residence was open and had pry marks along the side near the doorknob, and one of the door's glass panes had been broken out. On the east side of the residence, in the yard, several feet away from a side door, there was an ice pick with what appeared to be blood on it. This side door was open with no apparent damage to it, but there was a red-colored liquid that appeared to be blood on the interior side of the door near the doorknob. The side door was an entry/exit door of the den. On the den floor, several apparent bloodstains were visible. A trail of stains was between the den and master bedroom. In the master bedroom, there were apparent bloodstains on the floor, and a closed jewelry box was lying on its side on the bed. The white comforter near the jewelry box was marked with what appeared to be bloodstains. A half-eaten peanut butter cookie was also on the bed. In the remainder of the residence, the doors of the cabinets and dressers of each room were standing open. In the living room, the television was tuned to a music channel, and there was a half-eaten sandwich, an open bag of peanut butter cookies, and a partial glass of orange soda on the coffee table.

Reconstruction Worksheet

Scene	Action	Sequence No.	Relative Chronology
Den			
Bedroom			
Living room			
Dining room			
Kitchen			
Master bedroom			
Garage			
Outdoors			
Environment			

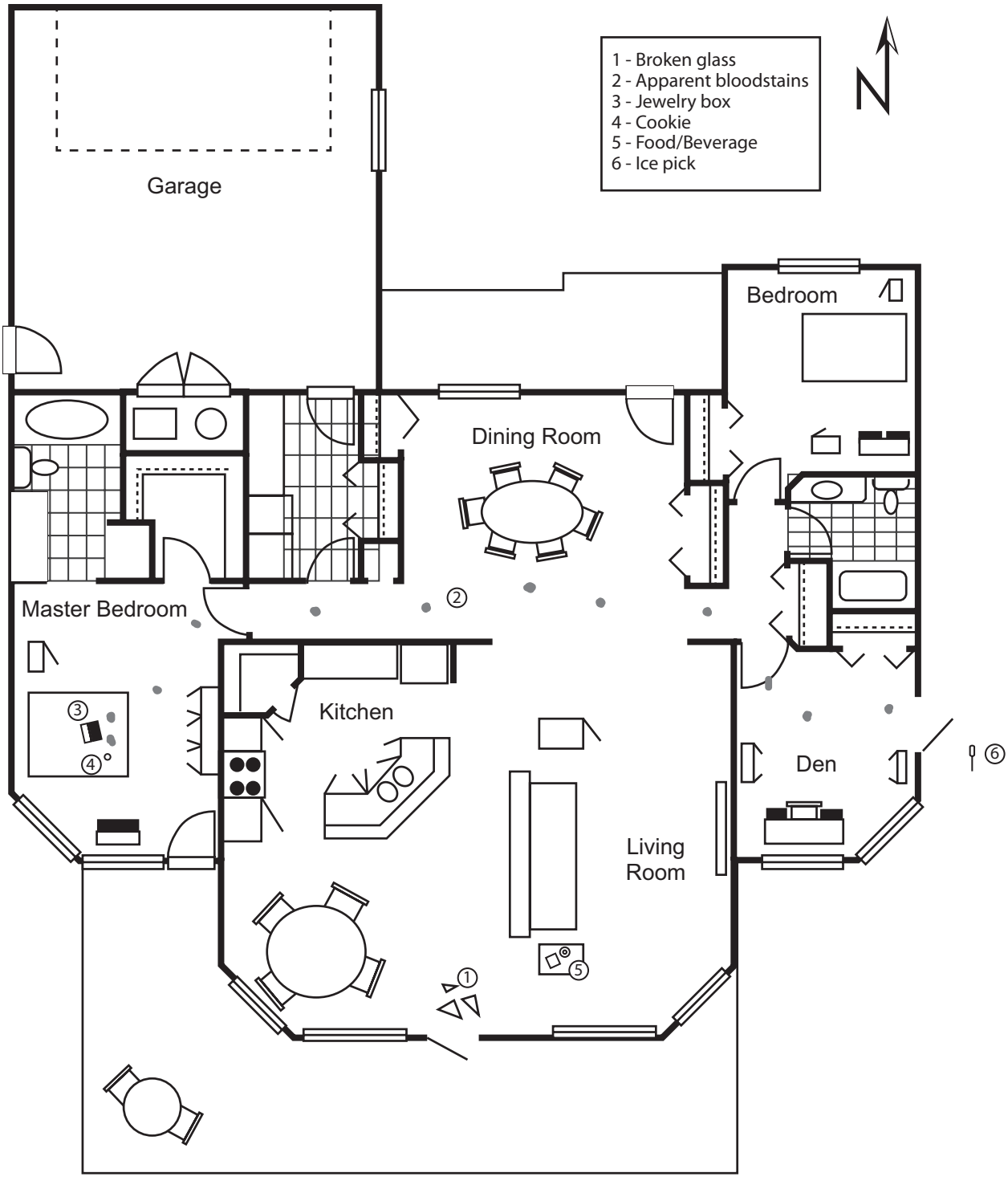

Figure 16.5
Scene diagram.

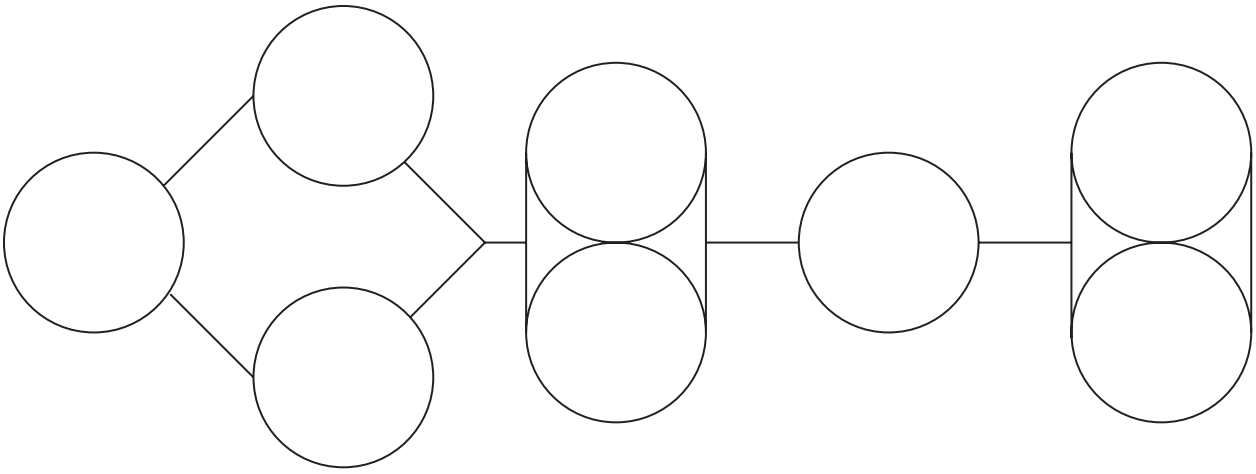

Figure 16.6
Flowchart 2.

Post Lab Questions

1. Name the seven steps associated with crime scene reconstruction.
2. Why is crime scene reconstruction important?
3. Define the following terms: *terminus peri quem*, *terminus post quem*, and *terminus ante quem*.
4. Give an example of when multiple crime scene reconstructions may be necessary.
5. Using the flowchart canvas, complete a flowchart given the following information:

Scene	Action	Sequence No.	Relative Chronology
Living room	Front door lock broken	1	Ante quem
	Footwear impressions exiting scene	3	Post quem
Kitchen	All cabinets open	2	Peri quem
Master bedroom	All dresser drawers open/ closet in disarray	2	Peri quem

Flowchart canvas

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